Test Data
For PMP21278 300W Buck-Boost
11/18/2017

Table of Contents

1. Design Specifications

Vin Minimum	**9VDC**
Vin Maximum	**50VDC**
Vout	**12VDC @ 25A**
Nominal Switching Frequency	**≈ 230KHz**

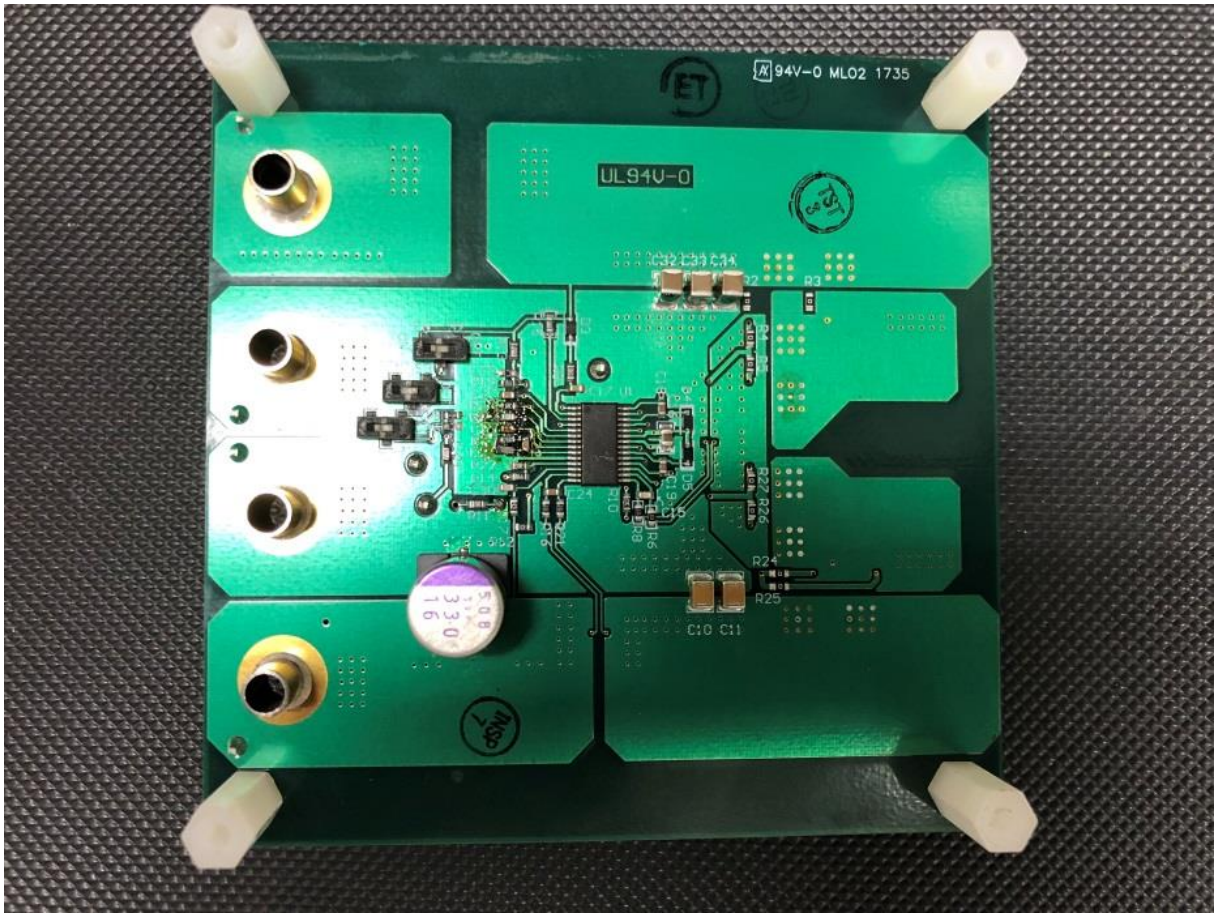
2. Design Specifications

PMP21278 is a 300W power supply utilizing the LM5176 4-switch buck-boost controller for industrial applications. This design can operate from 9V to 50V. The design has a 12V output and capable of sourcing 25A continuous current. Switching frequency is set to 230kHz. PMP21278 is assembled on SV601348A PCB. Three 6.8mF, 65V rated electrolytic capacitors are used to damp the input supply's wiring inductance for all test data taken on this test report.

3. Board Photo

Board Dimensions: 92.7mm x 92.7mm

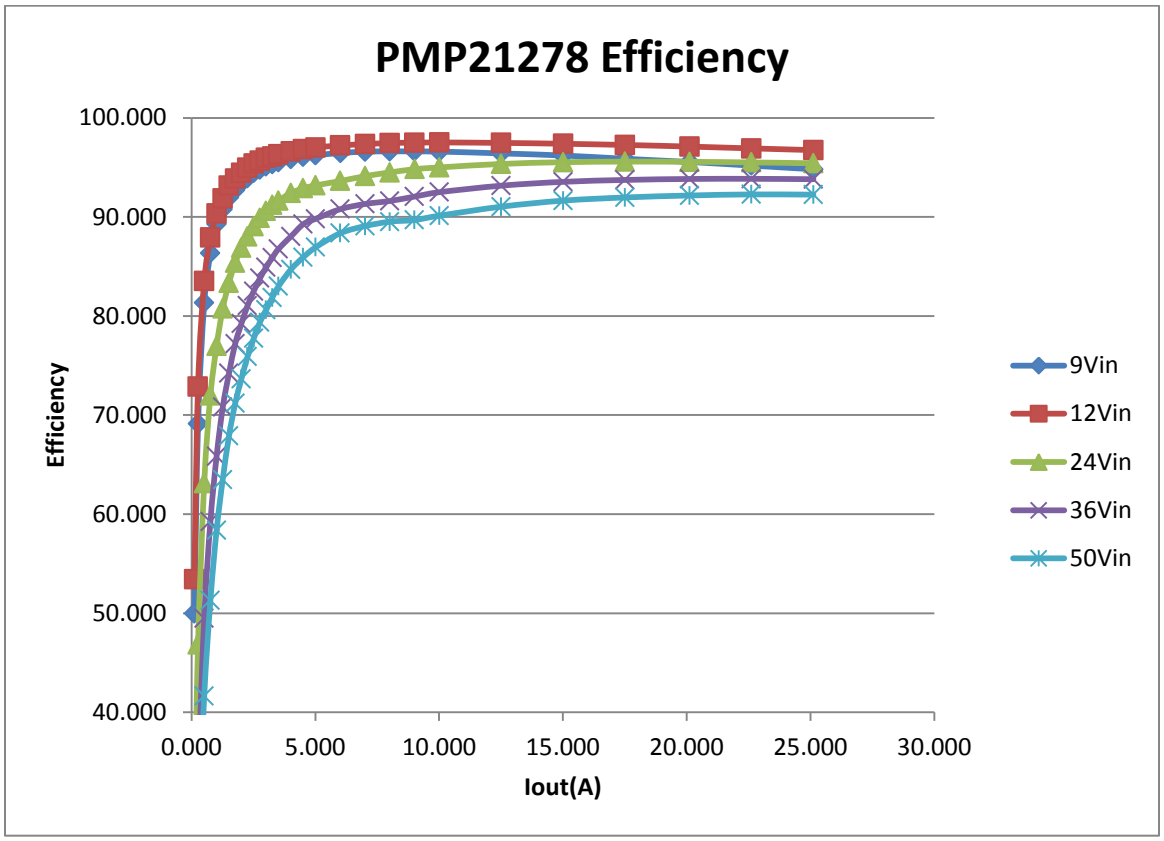
Board Photo (Top)



Board Photo (Bottom)

4. Efficiency

4.1 Efficiency Chart



4.2 Bode Plot

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Ploss(W)	Efficiency
9.032	0.310	12.063	0.116	2.800	1.399	1.401	49.976
9.033	0.510	12.064	0.264	4.607	3.185	1.422	69.137
9.033	0.844	12.064	0.514	7.624	6.201	1.423	81.339
9.033	1.182	12.064	0.764	10.677	9.217	1.460	86.329
9.033	1.520	12.064	1.016	13.730	12.257	1.472	89.277
9.033	1.860	12.065	1.264	16.801	15.250	1.551	90.769
9.032	2.202	12.065	1.516	19.889	18.290	1.599	91.961
9.033	2.542	12.065	1.764	22.961	21.283	1.677	92.695
9.033	2.880	12.066	2.014	26.014	24.300	1.714	93.412
9.032	3.218	12.065	2.262	29.066	27.291	1.775	93.893
9.033	3.556	12.066	2.514	32.121	30.333	1.787	94.435
9.033	3.896	12.066	2.764	35.191	33.351	1.840	94.772
9.032	4.234	12.066	3.014	38.244	36.368	1.876	95.095
9.033	4.574	12.066	3.264	41.315	39.384	1.931	95.327

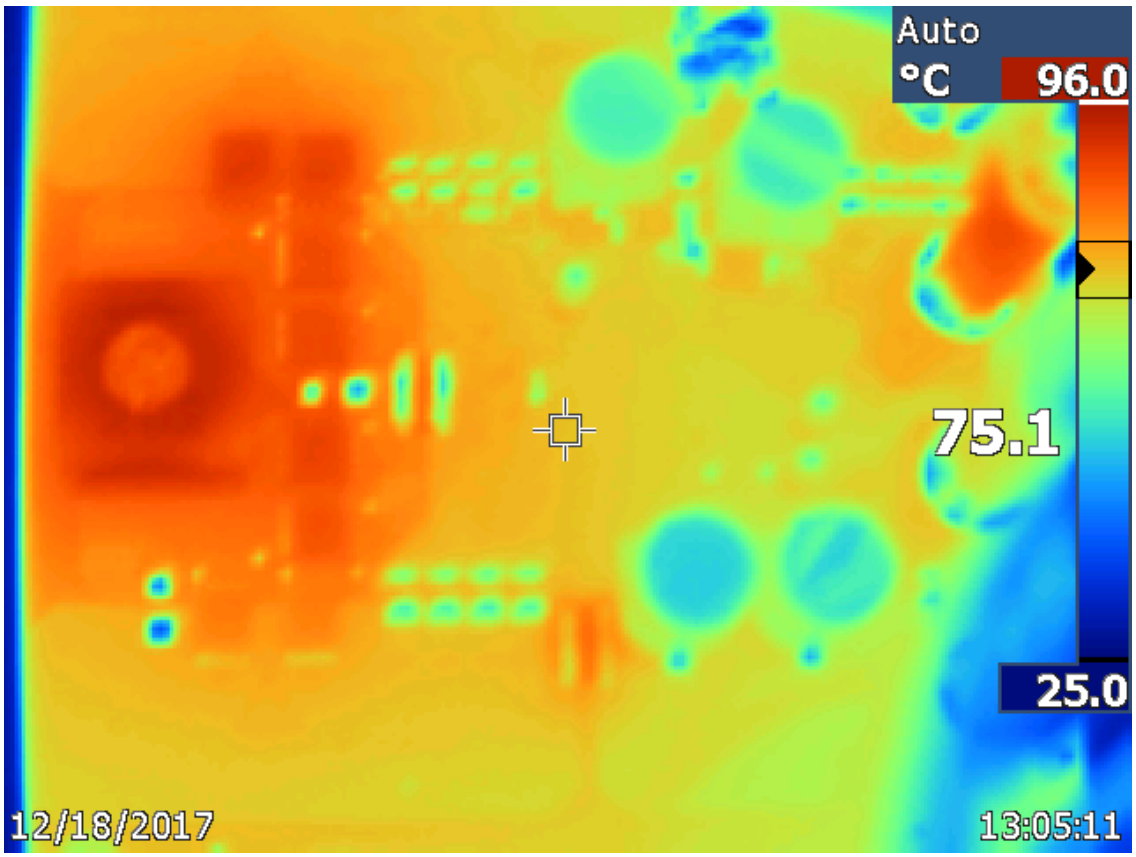
9.032	4.914	12.066	3.514	44.385	42.400	1.984	95.529
9.032	5.596	12.067	4.014	50.545	48.436	2.109	95.828
9.032	6.278	12.067	4.514	56.704	54.470	2.235	96.059
9.032	6.962	12.067	5.014	62.882	60.504	2.378	96.219
9.032	8.330	12.068	6.014	75.240	72.577	2.663	96.460
9.032	9.704	12.069	7.014	87.649	84.653	2.995	96.583
9.032	11.084	12.071	8.014	100.112	96.734	3.378	96.625
9.032	12.468	12.072	9.012	112.612	108.794	3.819	96.609
9.032	13.858	12.074	10.014	125.171	120.911	4.260	96.597
9.032	17.352	12.077	12.512	156.731	151.112	5.619	96.415
9.032	20.874	12.081	15.014	188.539	181.380	7.159	96.203
9.032	24.436	12.083	17.512	220.706	211.595	9.111	95.872
9.032	28.186	12.085	20.126	254.568	243.230	11.338	95.546
9.032	31.808	12.087	22.622	287.279	273.435	13.844	95.181
9.032	35.404	12.068	25.120	319.757	303.159	16.598	94.809
12.041	0.210	12.059	0.112	2.529	1.351	1.178	53.414
12.041	0.360	12.059	0.262	4.335	3.160	1.175	72.888
12.041	0.614	12.060	0.512	7.393	6.174	1.219	83.516
12.041	0.868	12.060	0.762	10.452	9.190	1.262	87.926
12.041	1.122	12.060	1.012	13.510	12.205	1.305	90.338
12.041	1.376	12.060	1.262	16.568	15.220	1.349	91.860
12.041	1.628	12.060	1.514	19.603	18.259	1.343	93.148
12.041	1.880	12.060	1.762	22.637	21.250	1.387	93.875
12.041	2.134	12.060	2.012	25.695	24.266	1.430	94.436
12.041	2.386	12.061	2.262	28.729	27.282	1.447	94.963
12.041	2.638	12.061	2.512	31.764	30.298	1.467	95.383
12.041	2.892	12.062	2.762	34.823	33.314	1.509	95.667
12.041	3.144	12.062	3.012	37.856	36.330	1.526	95.969
12.041	3.400	12.062	3.262	40.939	39.346	1.593	96.108
12.041	3.652	12.062	3.512	43.973	42.362	1.610	96.338
12.041	4.162	12.063	4.014	50.114	48.421	1.694	96.621
12.041	4.668	12.063	4.512	56.207	54.428	1.778	96.836
12.041	5.178	12.063	5.014	62.349	60.486	1.863	97.012
12.041	6.196	12.065	6.012	74.607	72.534	2.072	97.222
12.041	7.218	12.066	7.012	86.912	84.609	2.303	97.350
12.041	8.240	12.067	8.014	99.216	96.702	2.513	97.467
12.041	9.264	12.067	9.012	111.547	108.752	2.795	97.494
12.041	10.292	12.068	10.014	123.926	120.852	3.074	97.520
12.041	12.868	12.071	12.512	154.942	151.029	3.913	97.474

12.041	15.456	12.073	15.012	186.102	181.239	4.863	97.387
12.041	18.058	12.077	17.512	217.429	211.485	5.944	97.266
12.041	20.794	12.080	20.126	250.378	243.124	7.254	97.103
12.041	23.420	12.082	22.622	281.997	273.310	8.687	96.919
12.041	26.014	12.063	25.120	313.224	303.030	10.194	96.745
24.083	0.206	12.054	0.112	4.961	1.350	3.611	27.212
24.083	0.280	12.054	0.262	6.743	3.158	3.585	46.832
24.083	0.406	12.054	0.512	9.778	6.171	3.606	63.116
24.084	0.530	12.054	0.762	12.764	9.185	3.579	71.958
24.083	0.658	12.054	1.012	15.847	12.199	3.648	76.977
24.083	0.782	12.054	1.262	18.833	15.212	3.622	80.771
24.083	0.908	12.053	1.512	21.867	18.225	3.643	83.342
24.083	1.034	12.054	1.764	24.902	21.262	3.640	85.384
24.083	1.160	12.054	2.014	27.937	24.276	3.661	86.896
24.083	1.286	12.053	2.262	30.971	27.264	3.707	88.032
24.083	1.412	12.054	2.512	34.005	30.279	3.726	89.043
24.083	1.538	12.054	2.762	37.040	33.292	3.748	89.882
24.083	1.664	12.054	3.012	40.074	36.306	3.769	90.596
24.083	1.790	12.054	3.262	43.109	39.319	3.790	91.209
24.083	1.918	12.054	3.512	46.191	42.332	3.859	91.645
24.083	2.174	12.054	4.014	52.357	48.383	3.973	92.411
24.083	2.432	12.054	4.514	58.569	54.410	4.159	92.899
24.083	2.692	12.054	5.012	64.832	60.414	4.417	93.186
24.083	3.214	12.054	6.012	77.402	72.468	4.934	93.626
24.083	3.730	12.054	7.014	89.829	84.548	5.281	94.121
24.083	4.244	12.054	8.012	102.206	96.578	5.628	94.493
24.083	4.758	12.054	9.014	114.585	108.653	5.933	94.823
24.082	5.276	12.054	10.014	127.057	120.704	6.353	95.000
24.082	6.572	12.061	12.512	158.266	150.909	7.357	95.352
24.081	7.876	12.069	15.012	189.664	181.177	8.487	95.525
24.081	9.184	12.071	17.512	221.156	211.395	9.761	95.586
24.080	10.558	12.073	20.124	254.237	242.956	11.281	95.563
24.079	11.878	12.075	22.622	286.006	273.151	12.855	95.505
24.078	13.180	12.055	25.120	317.348	302.810	14.538	95.419
36.116	0.216	12.077	0.112	7.801	1.353	6.448	17.339
36.115	0.264	12.077	0.258	9.534	3.116	6.419	32.679
36.115	0.346	12.076	0.512	12.496	6.183	6.313	49.481
36.115	0.430	12.077	0.762	15.529	9.203	6.327	59.259

36.115	0.514	12.077	1.012	18.563	12.222	6.342	65.837
36.115	0.596	12.077	1.262	21.525	15.241	6.284	70.805
36.115	0.682	12.076	1.514	24.631	18.284	6.347	74.231
36.115	0.764	12.077	1.764	27.592	21.304	6.288	77.211
36.115	0.850	12.077	2.014	30.698	24.322	6.375	79.231
36.115	0.934	12.076	2.264	33.732	27.341	6.391	81.053
36.115	1.018	12.076	2.512	36.766	30.335	6.430	82.510
36.115	1.102	12.076	2.762	39.799	33.355	6.444	83.808
36.115	1.186	12.076	3.012	42.833	36.372	6.461	84.915
36.115	1.270	12.076	3.262	45.866	39.393	6.474	85.886
36.115	1.354	12.076	3.514	48.900	42.434	6.466	86.778
36.115	1.524	12.076	4.012	55.039	48.448	6.591	88.025
36.115	1.690	12.075	4.512	61.034	54.484	6.550	89.269
36.115	1.866	12.075	5.012	67.390	60.522	6.869	89.808
36.115	2.214	12.075	6.012	79.958	72.592	7.366	90.788
36.115	2.568	12.074	7.014	92.742	84.684	8.058	91.311
36.115	2.924	12.071	8.014	105.599	96.741	8.859	91.611
36.114	3.272	12.071	9.012	118.166	108.783	9.383	92.059
36.114	3.618	12.069	10.014	130.661	120.862	9.798	92.501
36.113	4.488	12.067	12.512	162.077	150.985	11.092	93.156
36.112	5.366	12.075	15.012	193.778	181.267	12.511	93.544
36.111	6.250	12.081	17.512	225.696	211.558	14.138	93.736
36.110	7.176	12.081	20.126	259.124	243.152	15.973	93.836
36.108	8.064	12.080	22.622	291.177	273.270	17.907	93.850
36.107	8.926	12.036	25.120	322.289	302.341	19.948	93.811
50.164	0.206	12.162	0.112	10.334	1.362	8.972	13.181
50.164	0.238	12.160	0.262	11.939	3.186	8.753	26.686
50.164	0.298	12.158	0.512	14.949	6.225	8.724	41.640
50.164	0.360	12.156	0.762	18.059	9.263	8.796	51.291
50.164	0.420	12.154	1.012	21.069	12.299	8.770	58.377
50.164	0.480	12.151	1.258	24.079	15.285	8.793	63.480
50.164	0.540	12.149	1.514	27.089	18.393	8.696	67.899
50.164	0.600	12.147	1.764	30.098	21.427	8.671	71.190
50.164	0.662	12.145	2.014	33.209	24.460	8.749	73.656
50.164	0.722	12.142	2.264	36.219	27.490	8.728	75.901
50.164	0.782	12.140	2.512	39.228	30.496	8.733	77.739
50.164	0.842	12.139	2.762	42.238	33.528	8.711	79.377
50.164	0.904	12.137	3.012	45.348	36.557	8.791	80.614
50.164	0.964	12.136	3.262	48.358	39.587	8.771	81.862

50.164	1.024	12.134	3.514	51.368	42.638	8.730	83.004
50.164	1.146	12.131	4.014	57.488	48.692	8.796	84.699
50.164	1.270	12.128	4.514	63.708	54.745	8.964	85.930
50.164	1.394	12.125	5.014	69.929	60.796	9.132	86.941
50.164	1.644	12.121	6.012	82.469	72.872	9.597	88.362
50.164	1.902	12.118	7.014	95.411	84.993	10.418	89.081
50.163	2.162	12.115	8.014	108.453	97.091	11.362	89.524
50.163	2.426	12.111	9.012	121.696	109.148	12.547	89.690
50.163	2.682	12.109	10.014	134.536	121.259	13.278	90.131
50.162	3.316	12.103	12.512	166.337	151.432	14.906	91.039
50.161	3.952	12.101	15.014	198.238	181.683	16.555	91.649
50.160	4.596	12.106	17.514	230.535	212.016	18.519	91.967
50.158	5.274	12.114	20.126	264.535	243.815	20.720	92.167
50.157	5.922	12.116	22.622	297.027	274.078	22.949	92.274
50.155	6.546	12.057	25.120	328.313	302.879	25.434	92.253

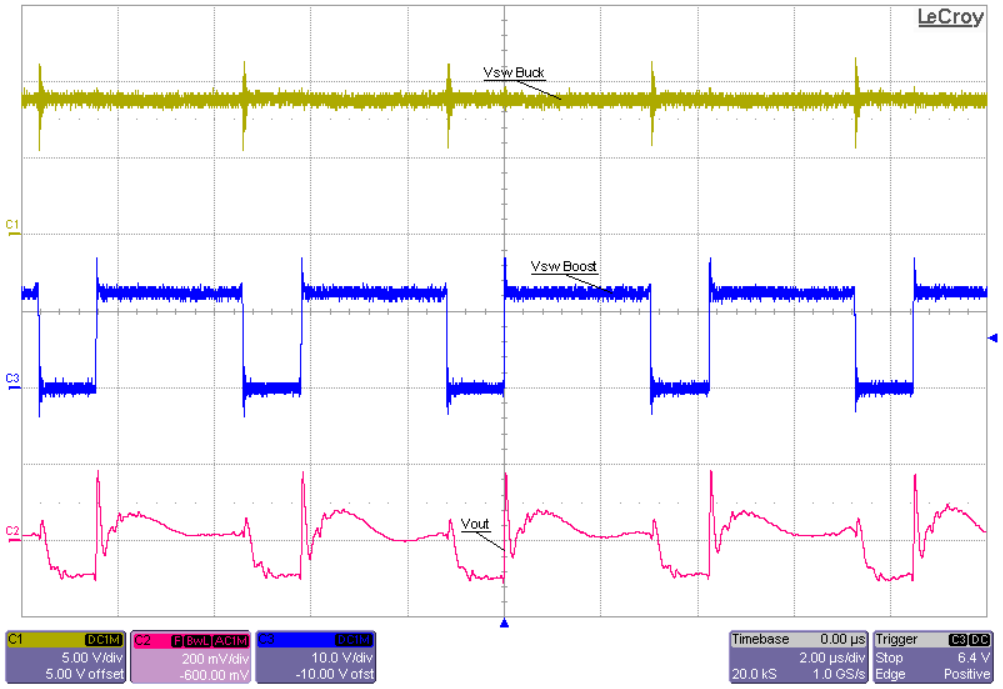
5. Thermal



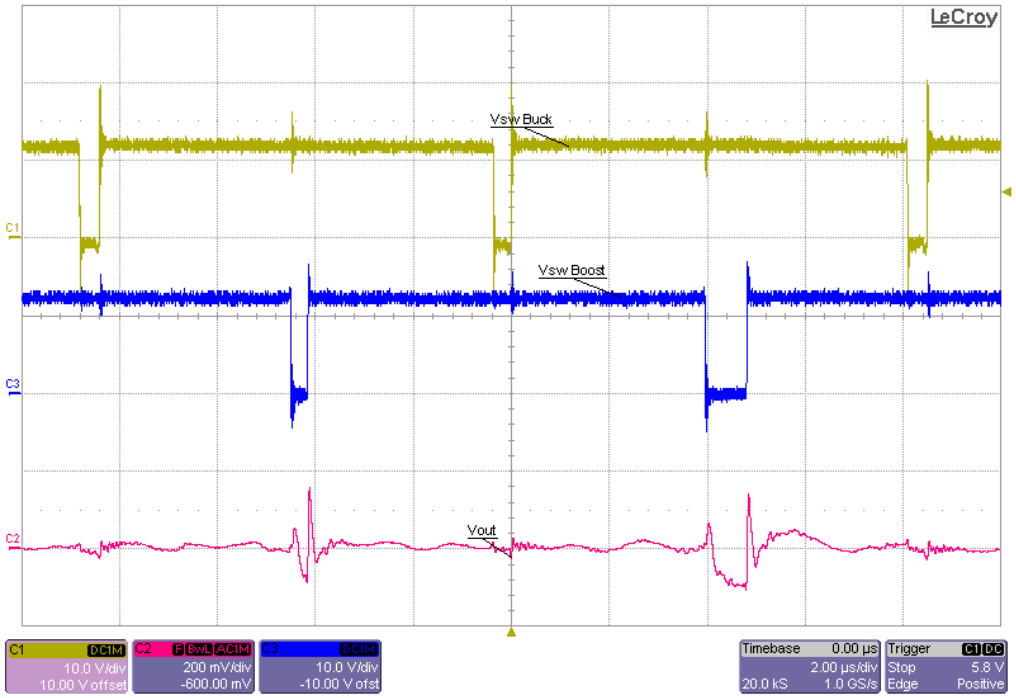
Thermal shot is take after thermal equilibrium without airflow, 12Vin, 12Vout full load.

6. Waveforms

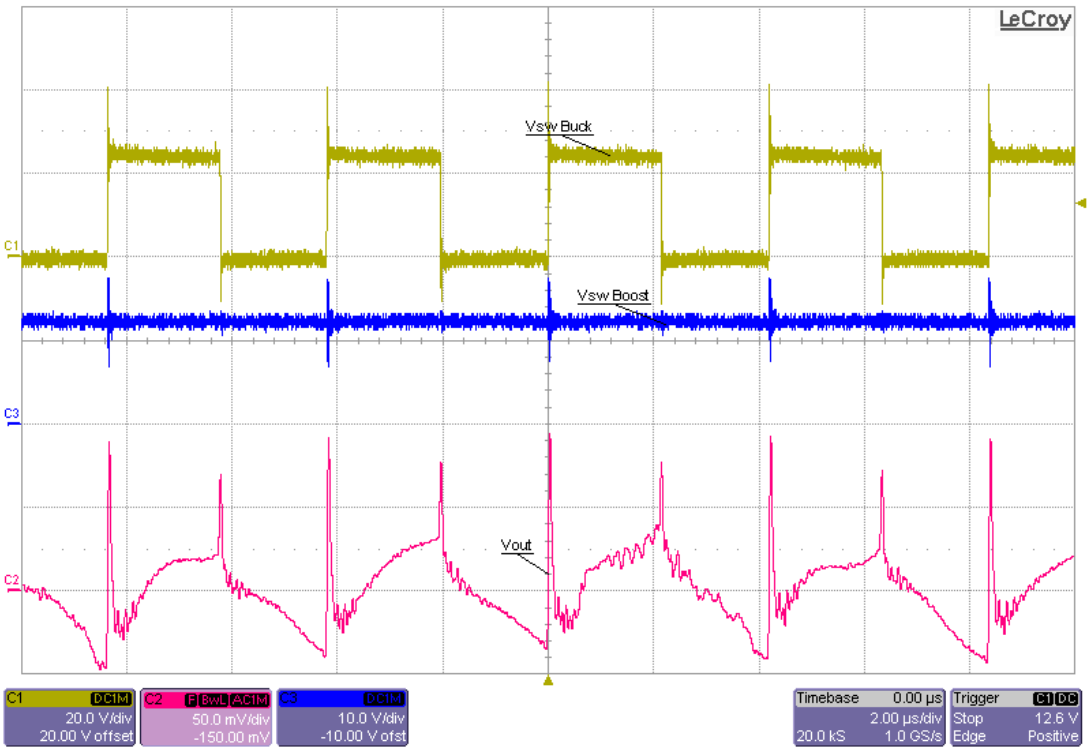
6.1 Switching Waveform and Output Ripple



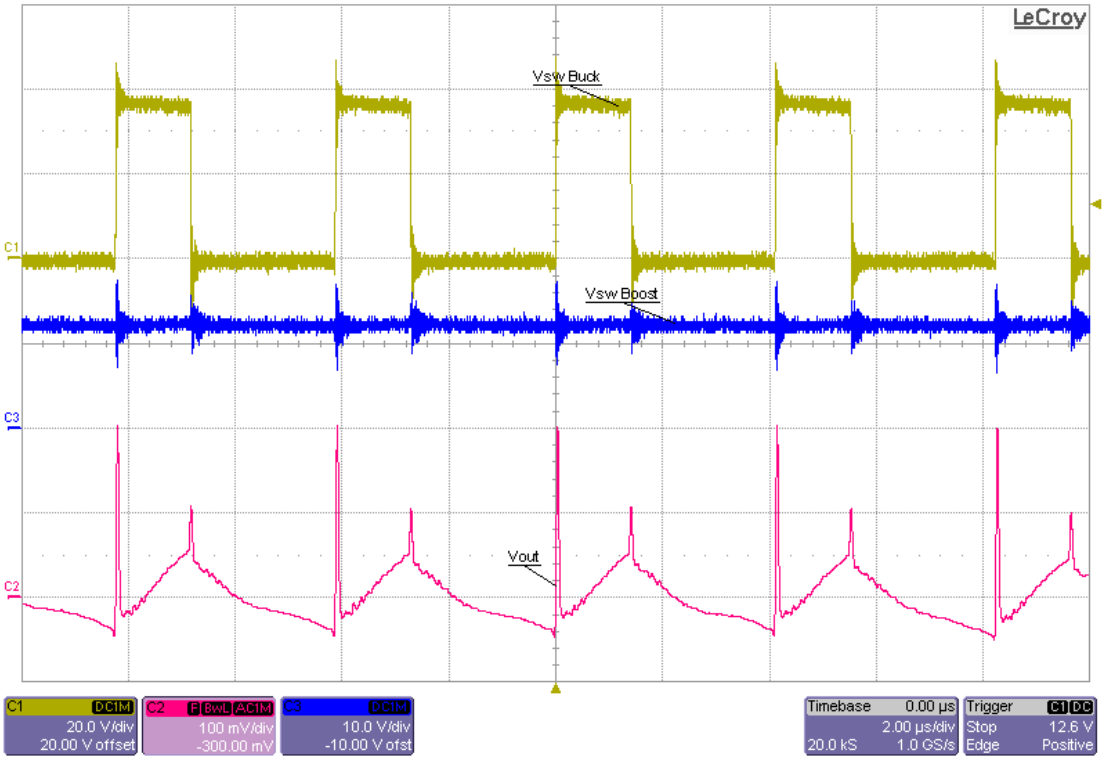
9Vin, 12Vout, full load. Ch1 buck switch, Ch3 boost switch, Ch2 output AC coupled.



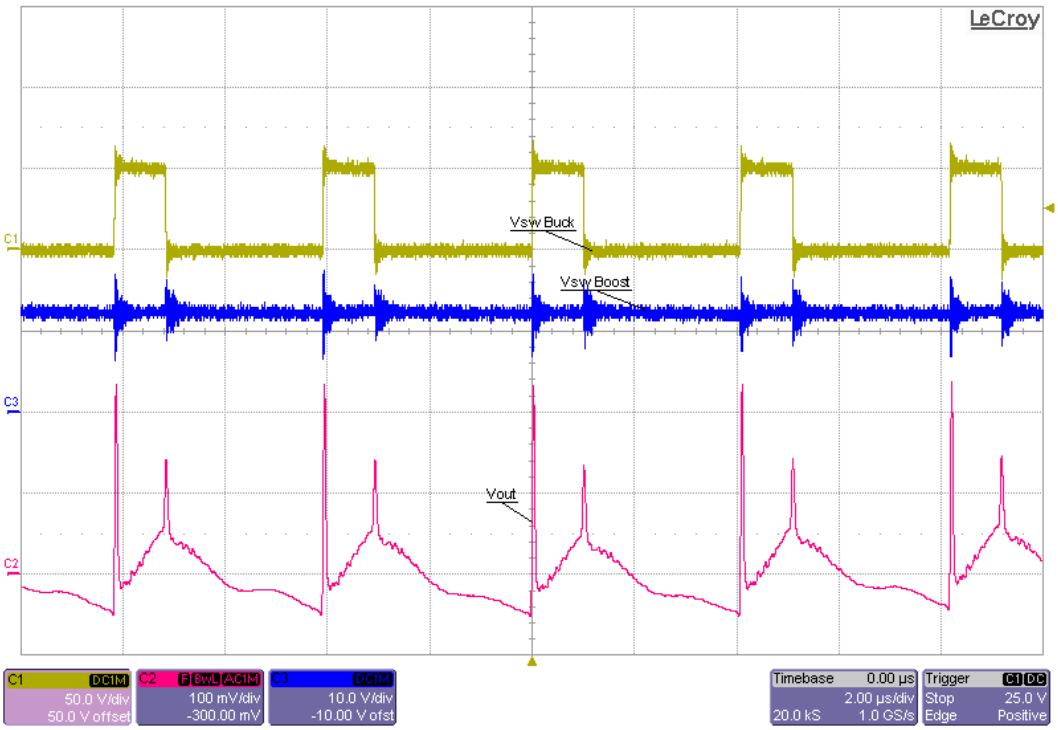
12Vin, 12Vout, full load. Ch1 buck switch, Ch3 boost switch, Ch2 output AC coupled.



24Vin, 12Vout, full load. Ch1 buck switch, Ch3 boost switch, Ch2 output AC coupled.

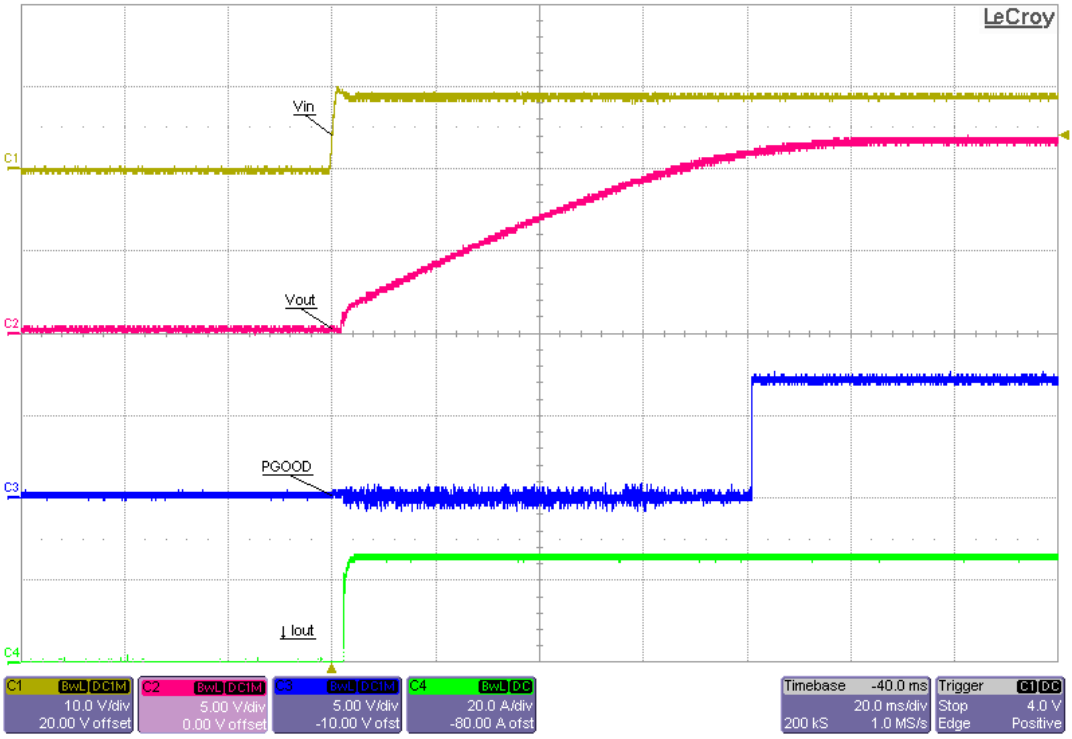


36Vin, 12Vout, full load. Ch1 buck switch, Ch3 boost switch, Ch2 output AC coupled.

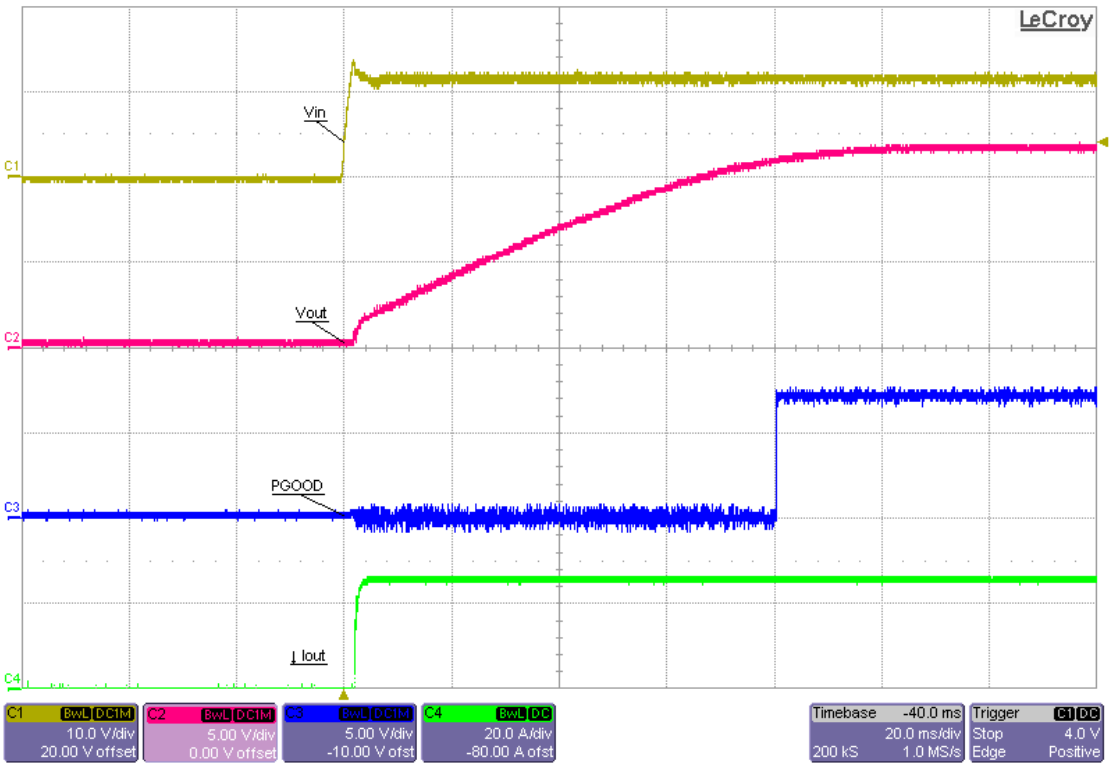


50Vin, 12Vout, full load. Ch1 buck switch, Ch3 boost switch, Ch2 output AC coupled.

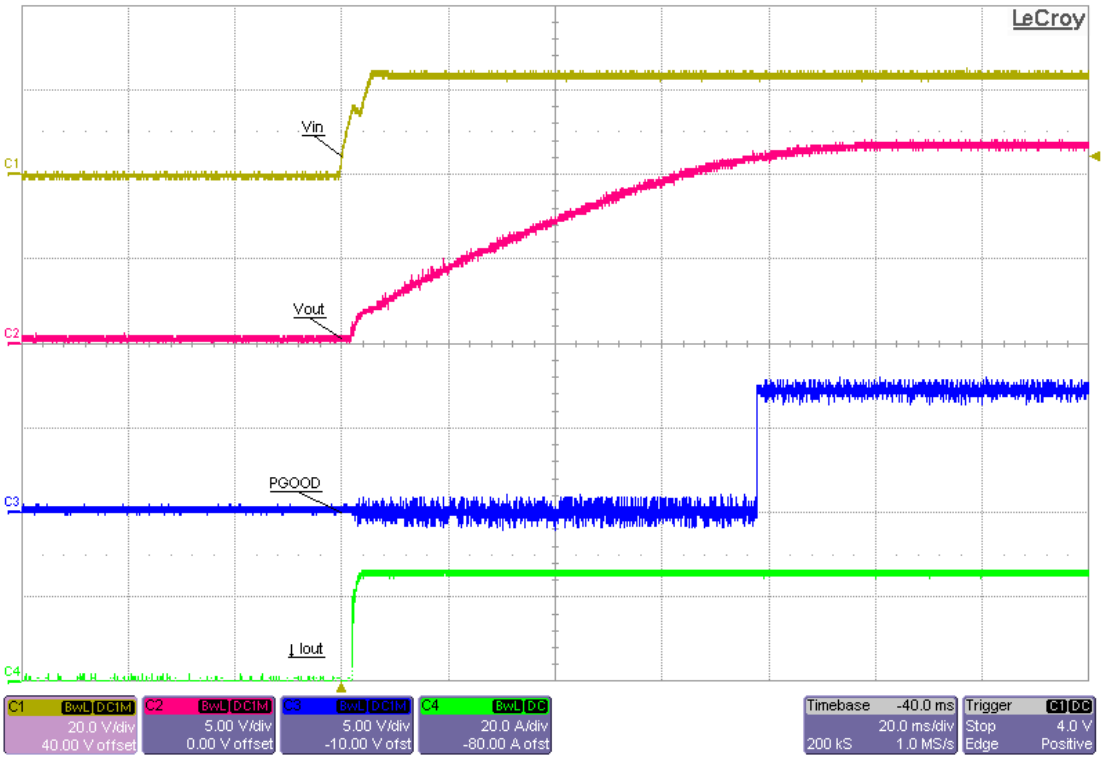
6.2 Start Up



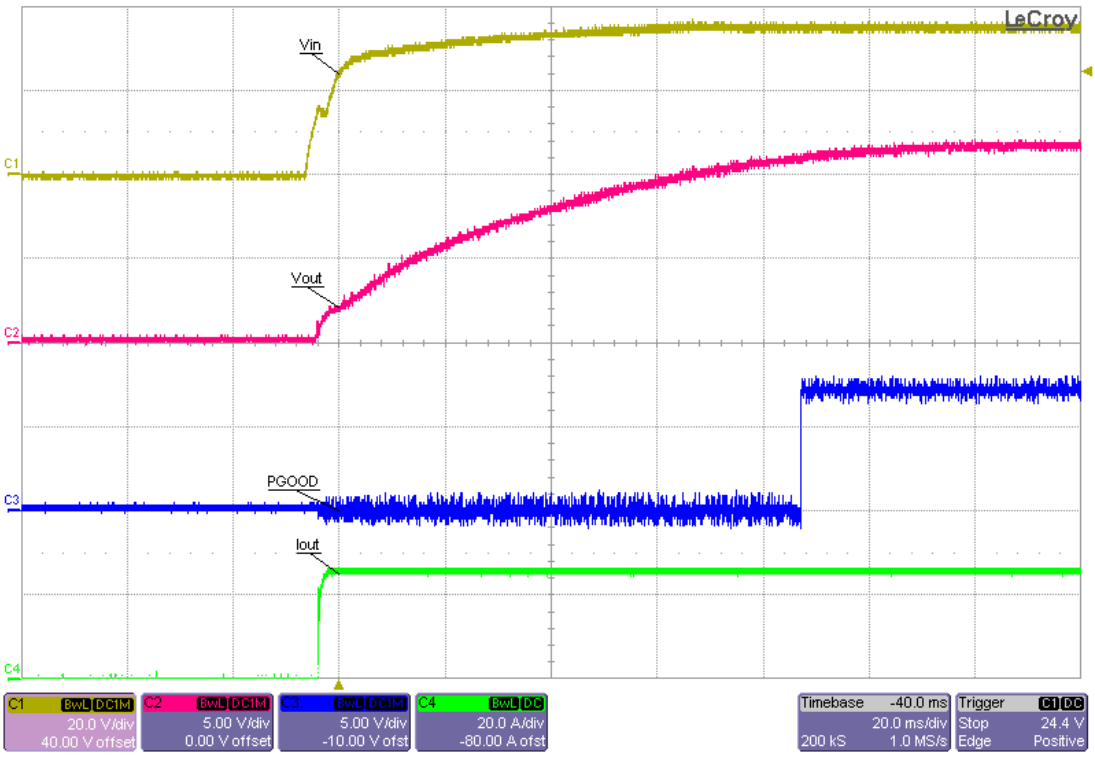
9Vin, 12Vout at full load. Ch1 Vin, Ch2 Vout, Ch3 PGOOD, and Ch4 Iout.



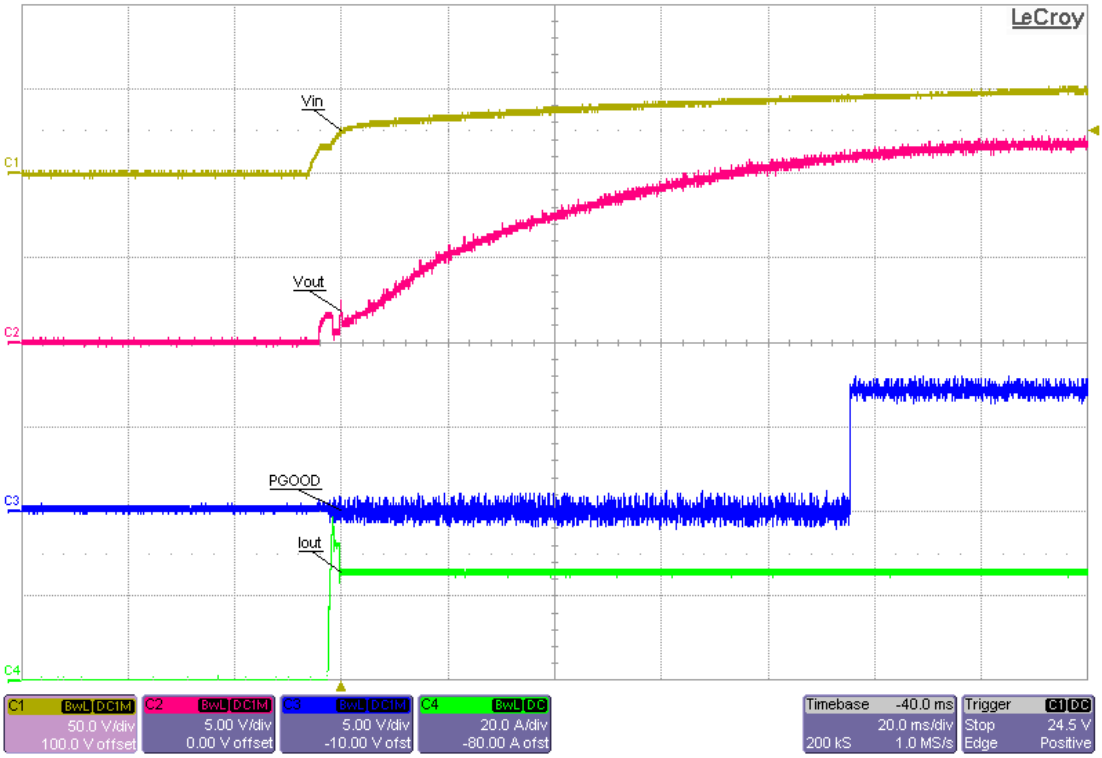
12Vin, 12Vout at full load. Ch1 Vin, Ch2 Vout, Ch3 PGOOD, and Ch4 Iout.



24Vin, 12Vout at full load. Ch1 Vin, Ch2 Vout, Ch3 PGOOD, and Ch4 Iout.

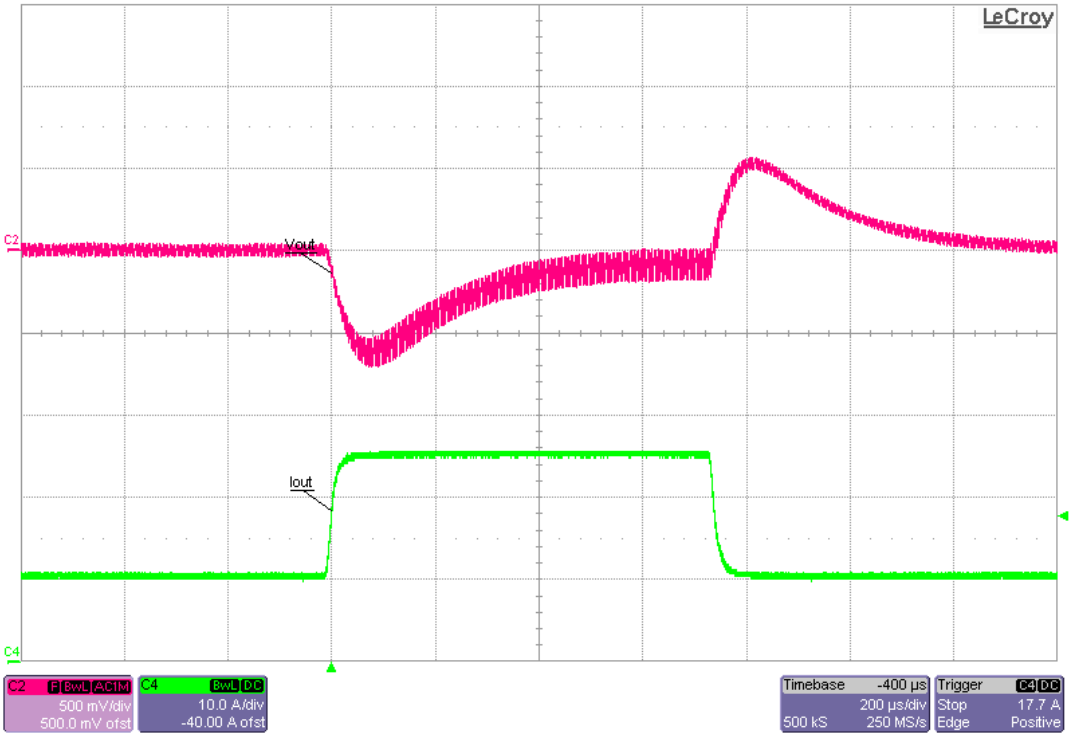


36Vin, 12Vout at full load. Ch1 Vin, Ch2 Vout, Ch3 PGOOD, and Ch4 Iout.

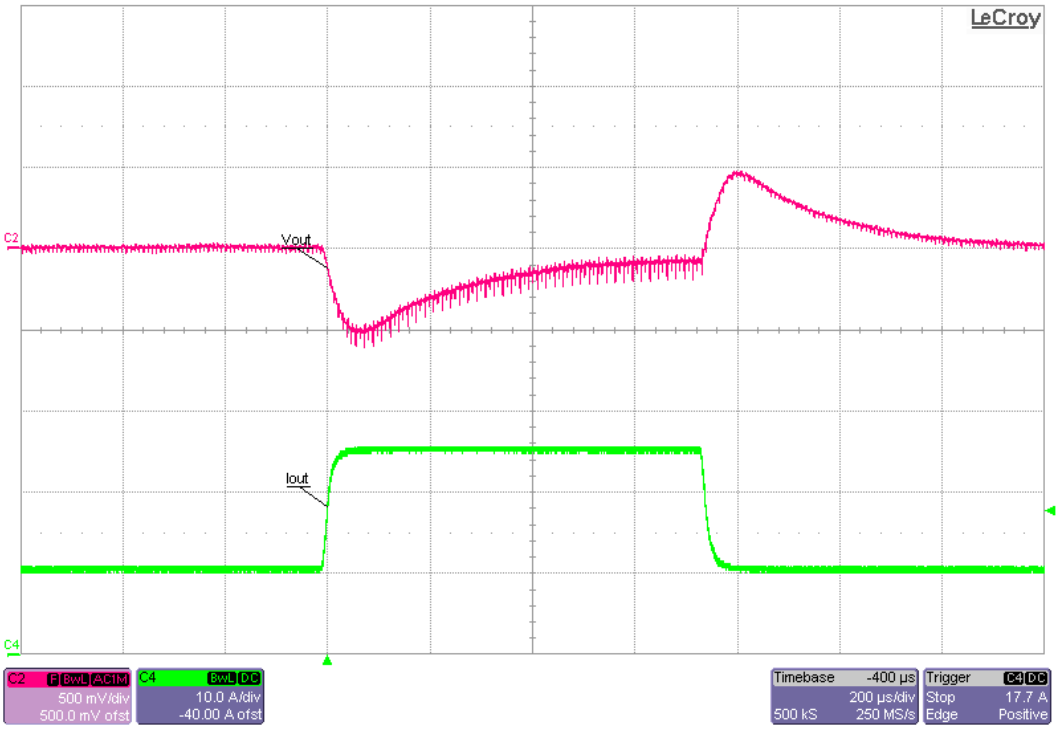


50Vin, 12Vout at full load. Ch1 Vin, Ch2 Vout, Ch3 PGOOD, and Ch4 Iout.

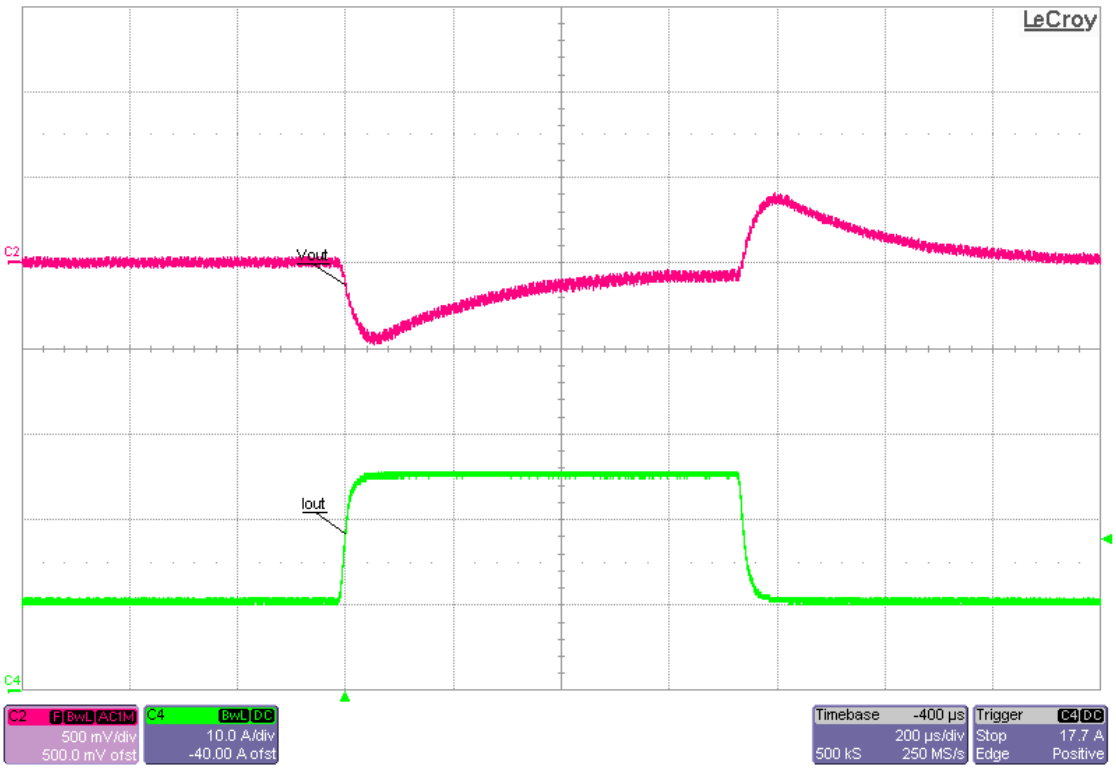
6.3 Transient Response



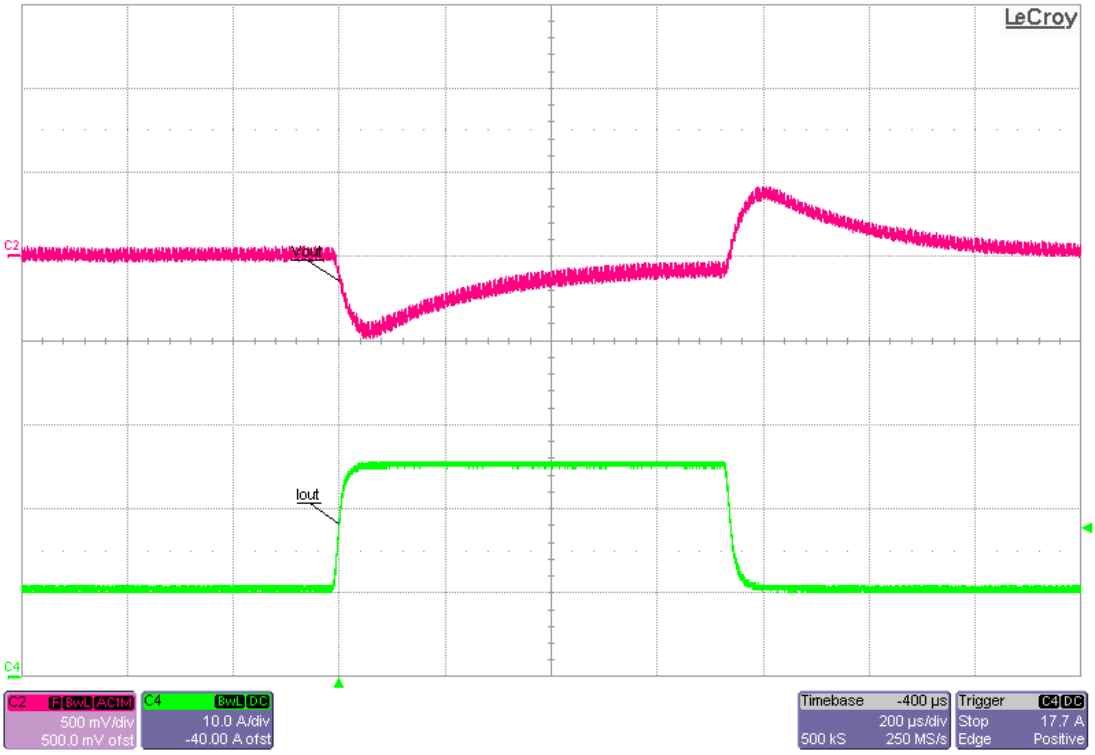
9Vin, 12Vout 10A to 25A load transient. Ch4 measures Iout, and Ch2 measures Vout.



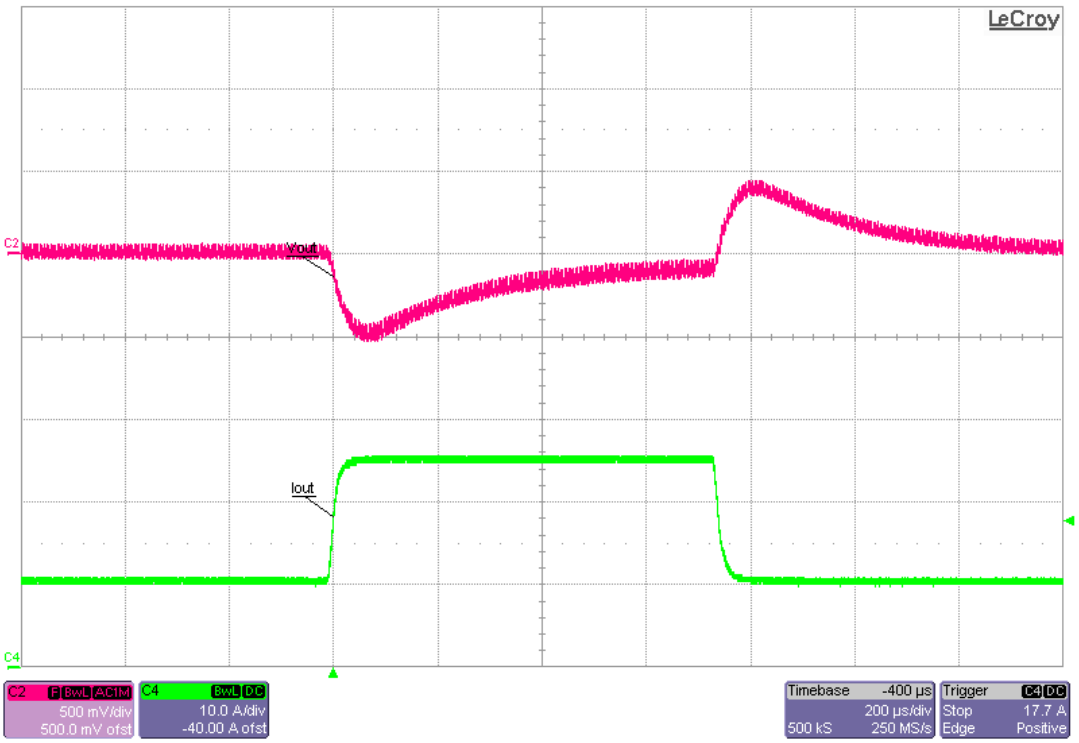
12Vin, 12Vout 10A to 25A load transient. Ch4 measures Iout, and Ch2 measures Vout.



24Vin, 12Vout 10A to 25A load transient. Ch4 measures Iout, and Ch2 measures Vout.

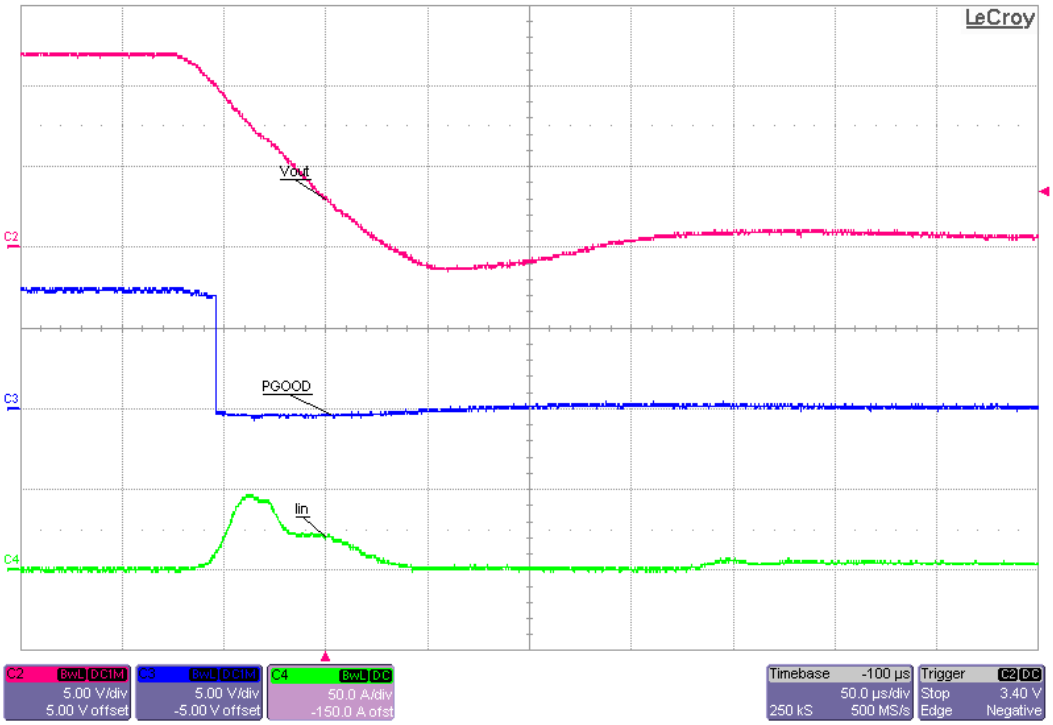


36Vin, 12Vout 10A to 25A load transient. Ch4 measures Iout, and Ch2 measures Vout.

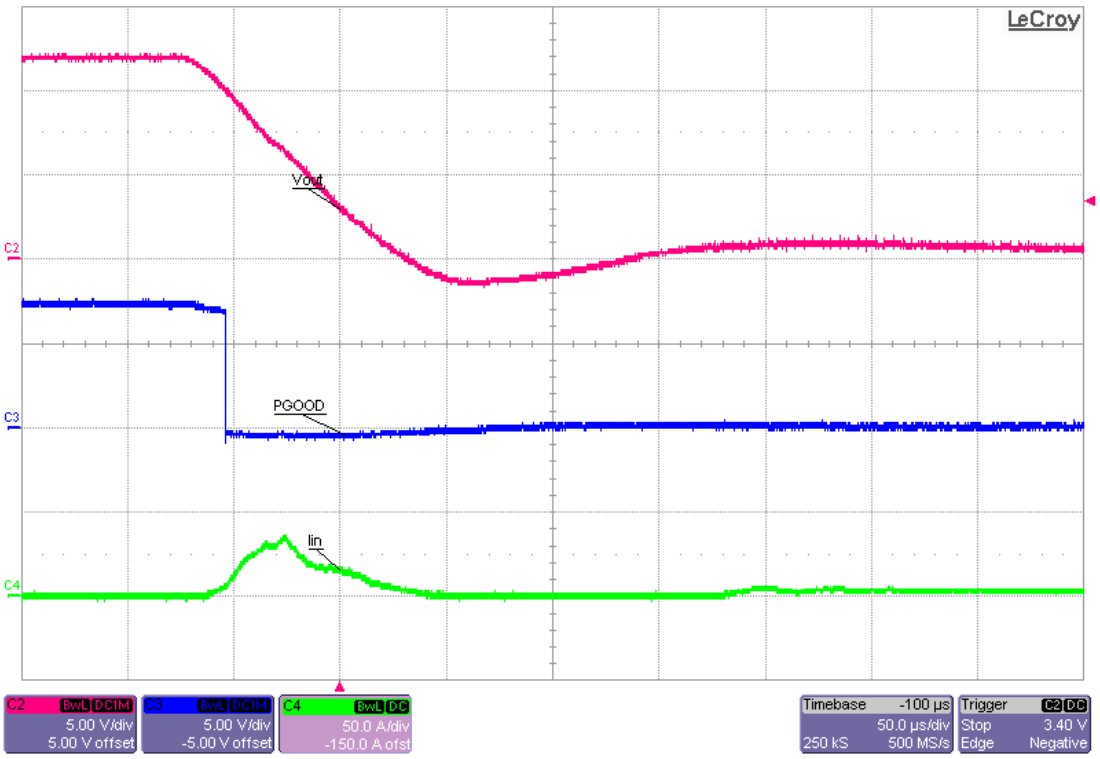


50Vin, 12Vout 10A to 25A load transient. Ch4 measures Iout, and Ch2 measures Vout.

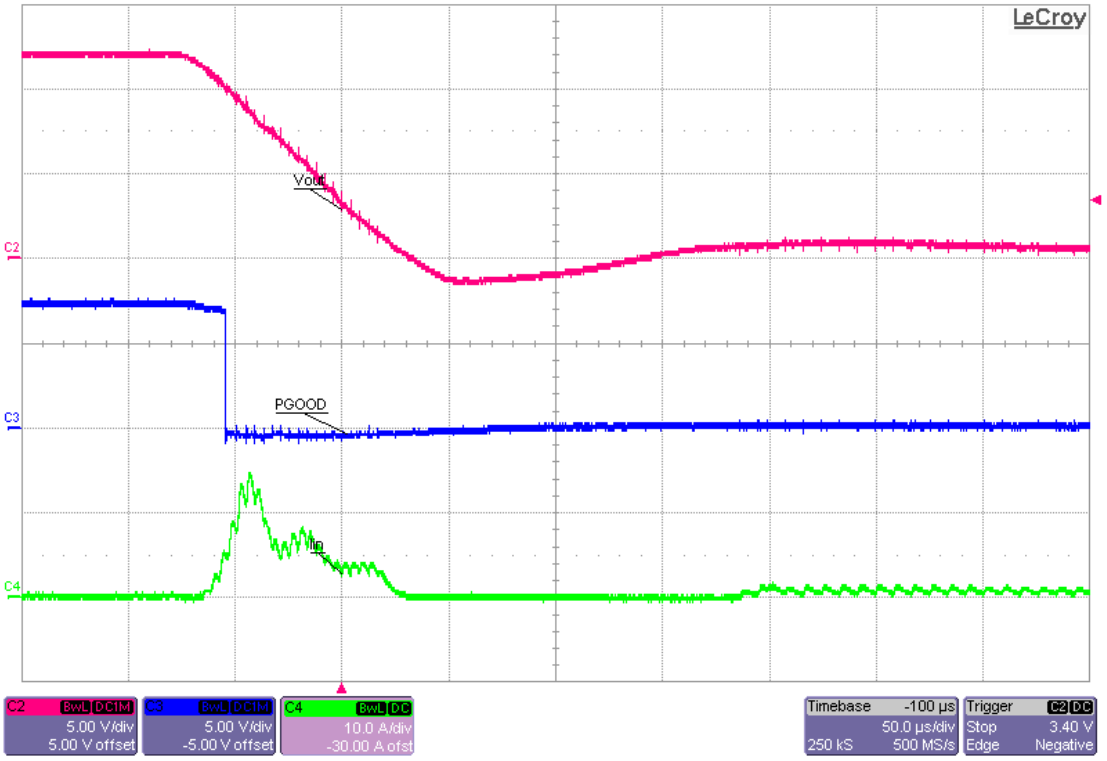
6.4 Short Circuit



9Vin, 12Vout, no load short circuit, Ch2 Vout, Ch3 PGOOD, Ch4 Iin

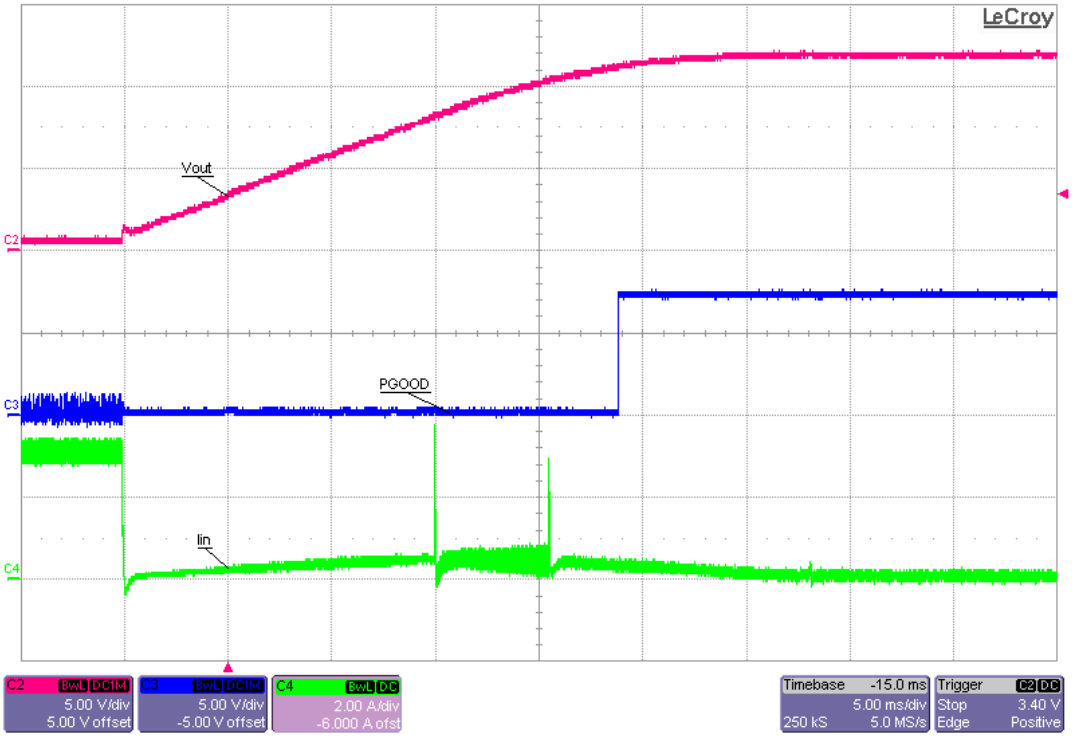


12Vin, 12Vout, no load short circuit, Ch2 Vout, Ch3 PGOOD, Ch4 Iin

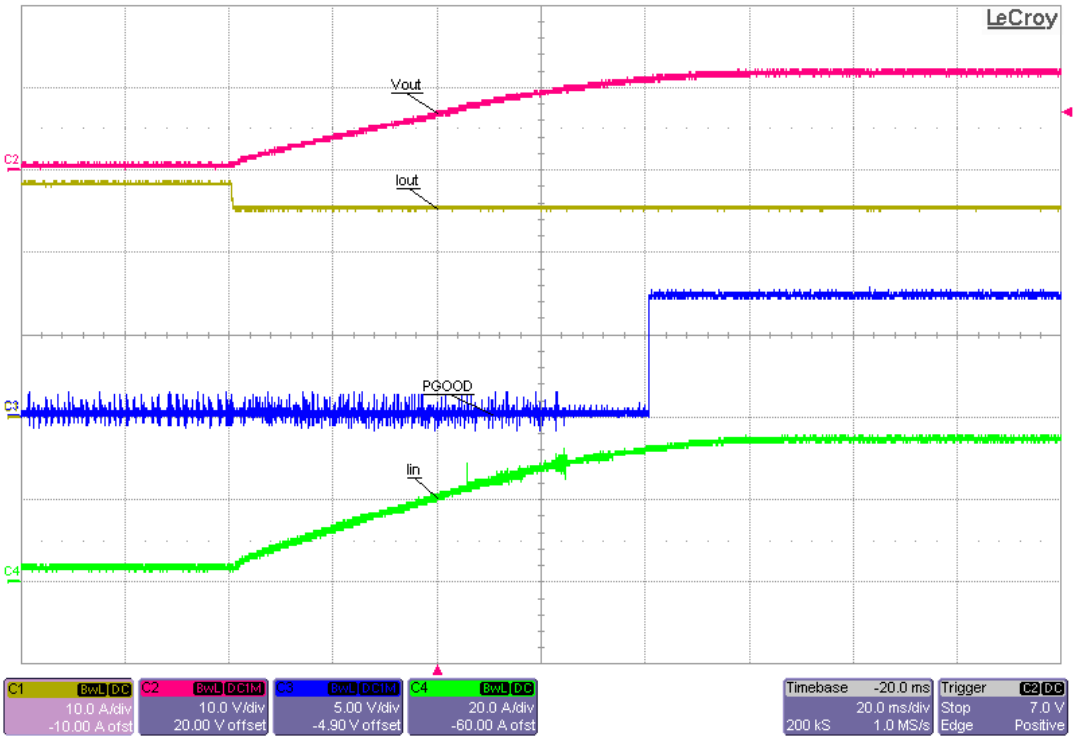


50Vin, 12Vout, no load short circuit, Ch2 Vout, Ch3 PGOOD, Ch4 Iin

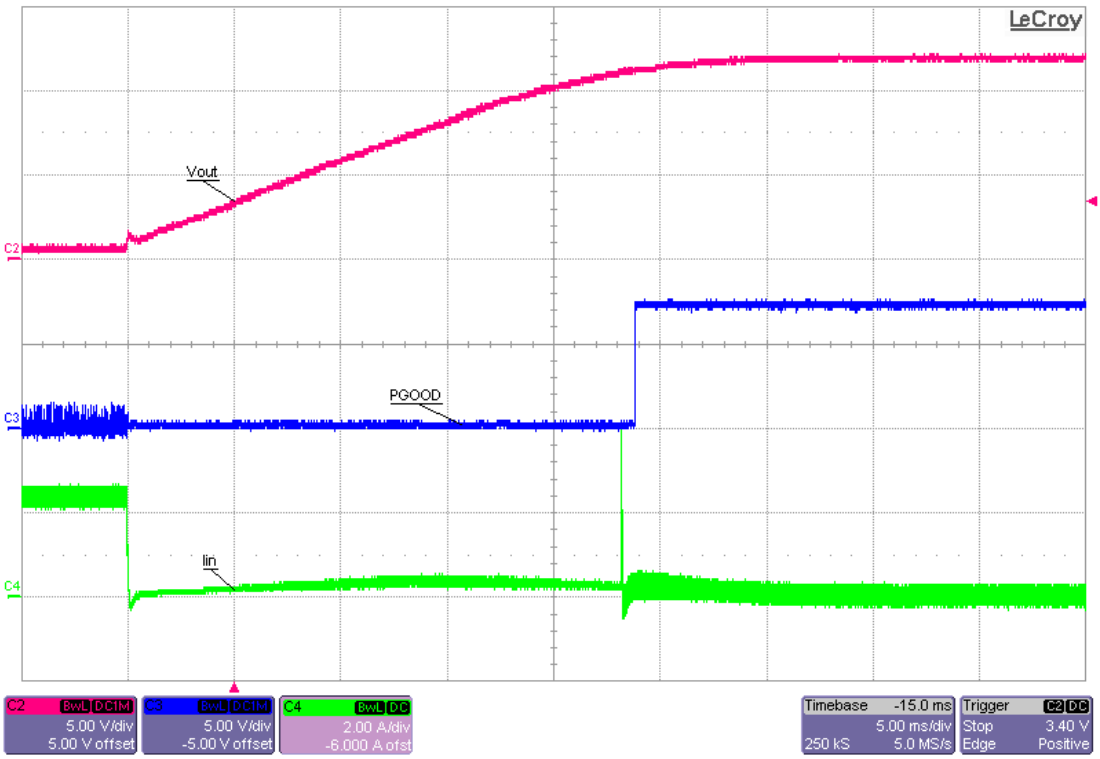
6.5 Short Circuit Recovery



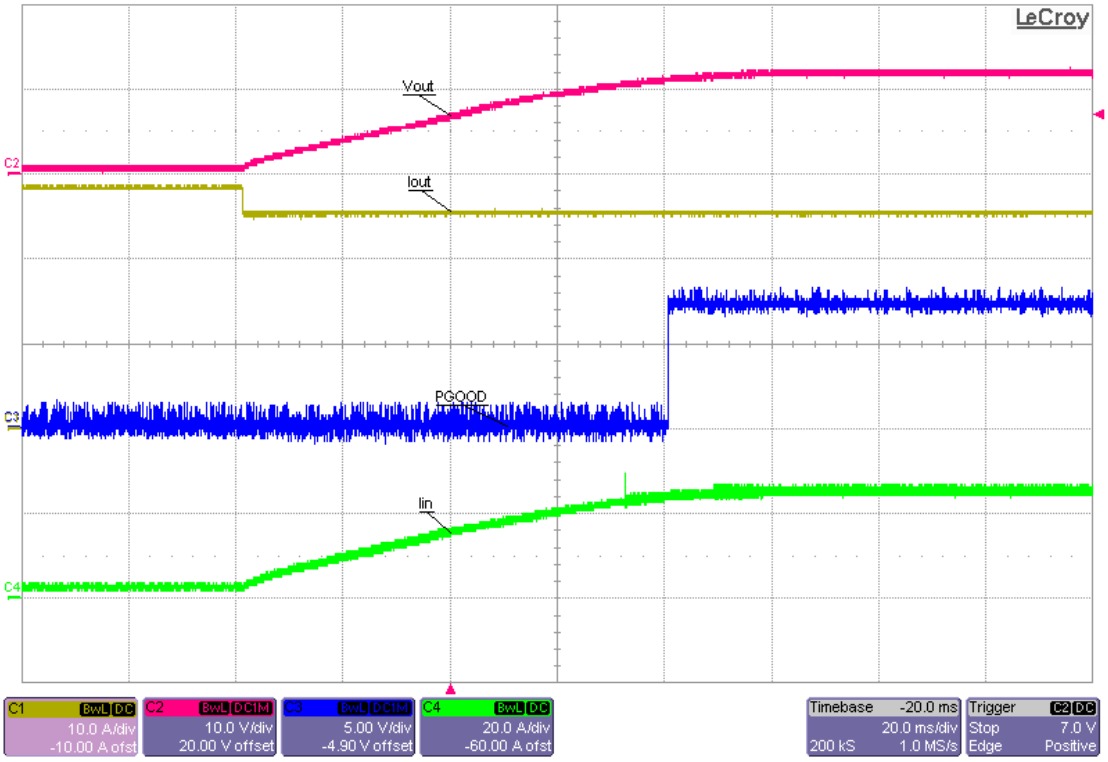
9Vin, 12Vout, no load short circuit recovery, Ch2 Vout, Ch3 PGOOD, Ch4 Iin



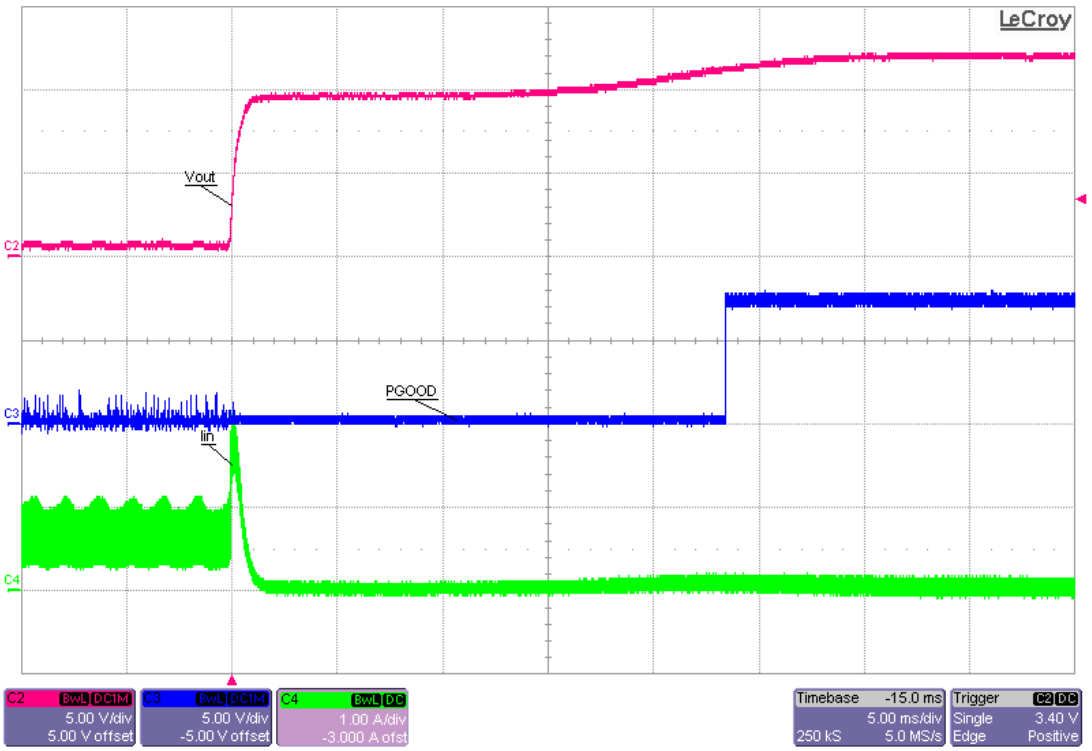
9Vin, 12Vout, full load short circuit recovery, Ch1 Iout, Ch2 Vout, Ch3 PGOOD, Ch4 Iin



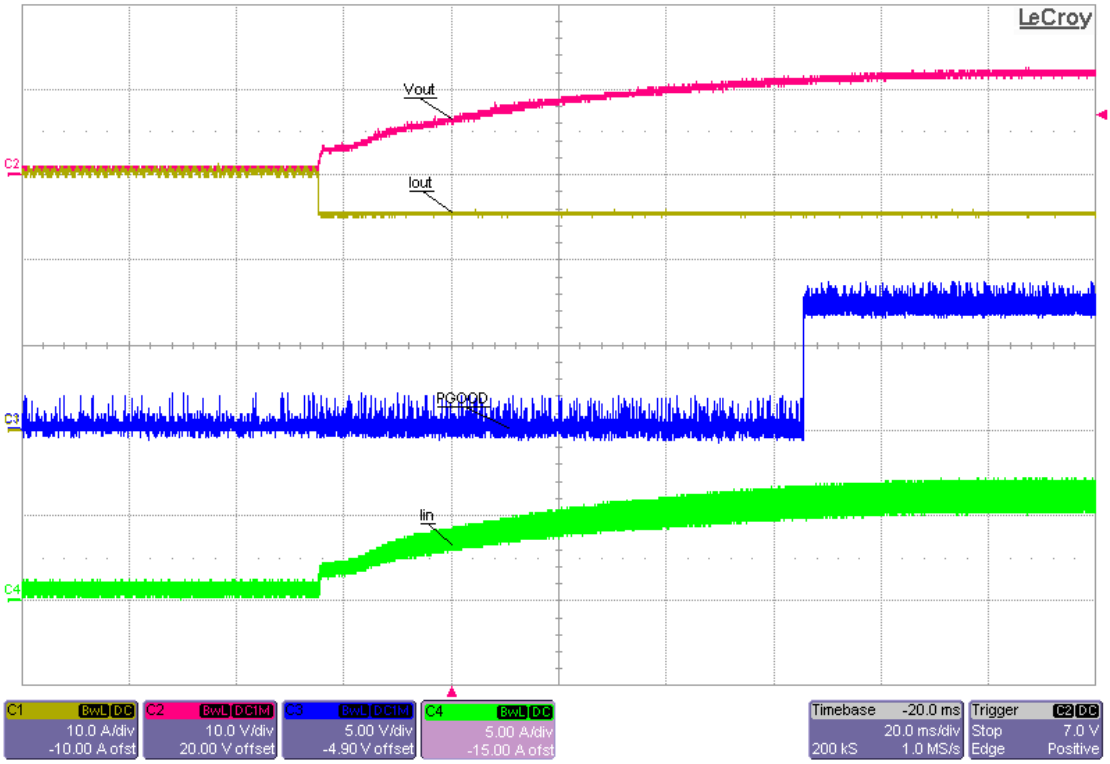
12Vin, 12Vout, no load short circuit recovery, Ch2 Vout, Ch3 PGOOD, Ch4 Iin



12Vin, 12Vout, full load short circuit recovery, Ch1 Iout, Ch2 Vout, Ch3 PGOOD, Ch4 Iin

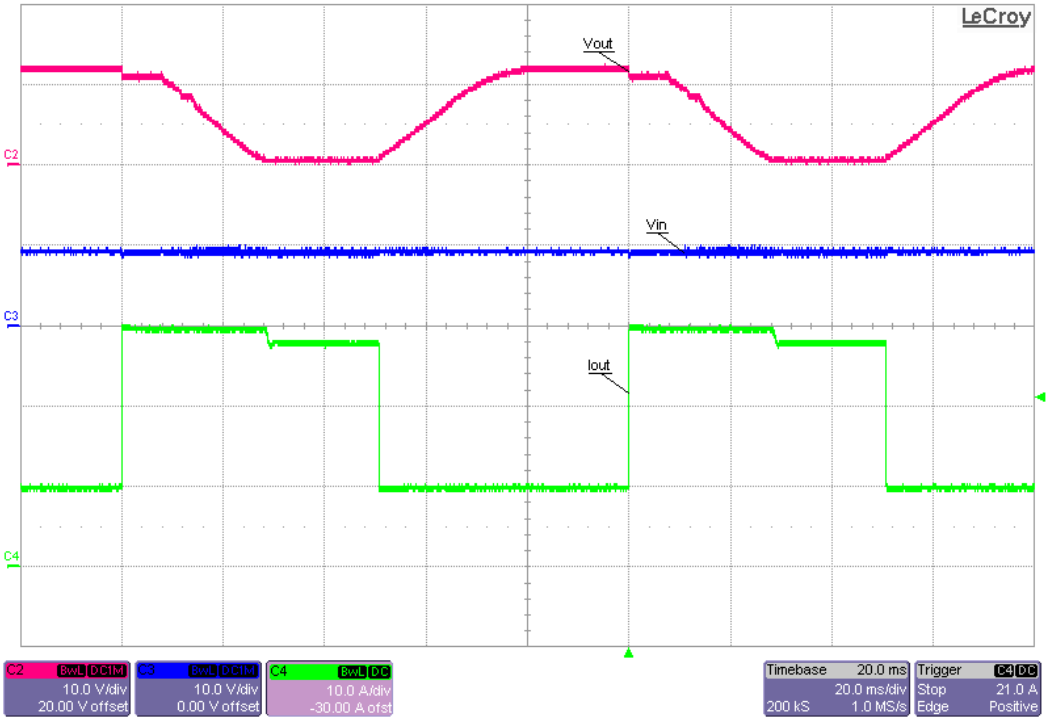


50Vin, 12Vout, no load short circuit recovery, Ch2 Vout, Ch3 PGOOD, Ch4 Iin

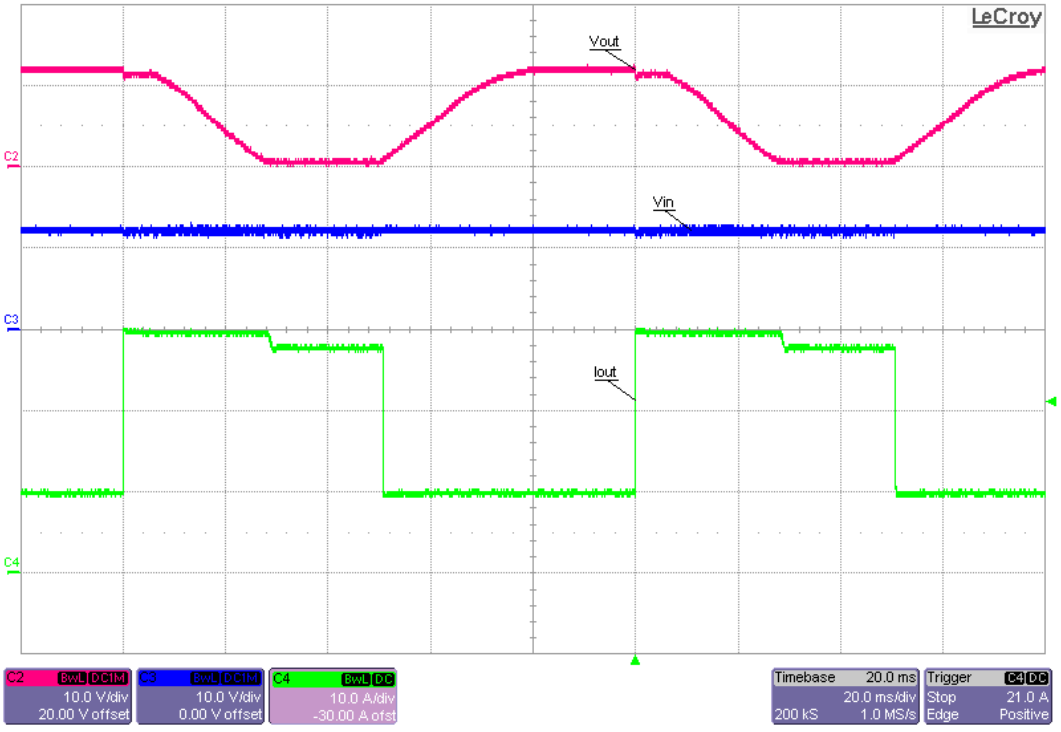


50Vin, 12Vout, full load short circuit recovery, Ch2 Vout, Ch3 PGOOD, Ch4 Iin

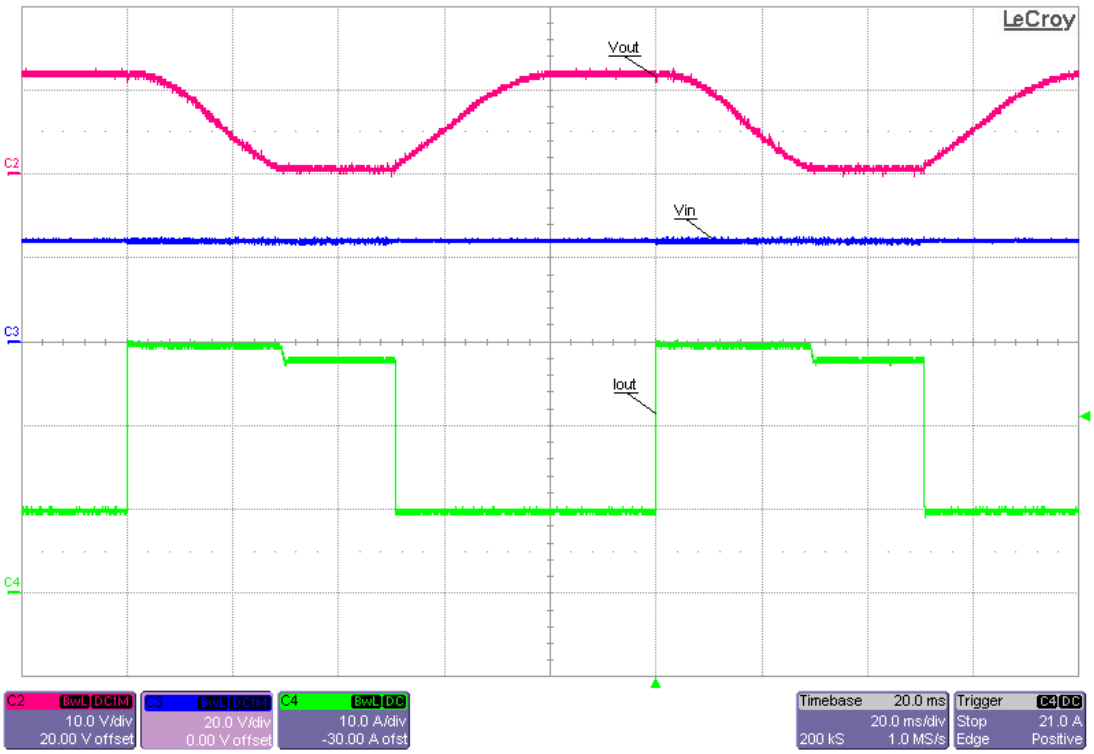
6.6 Overload



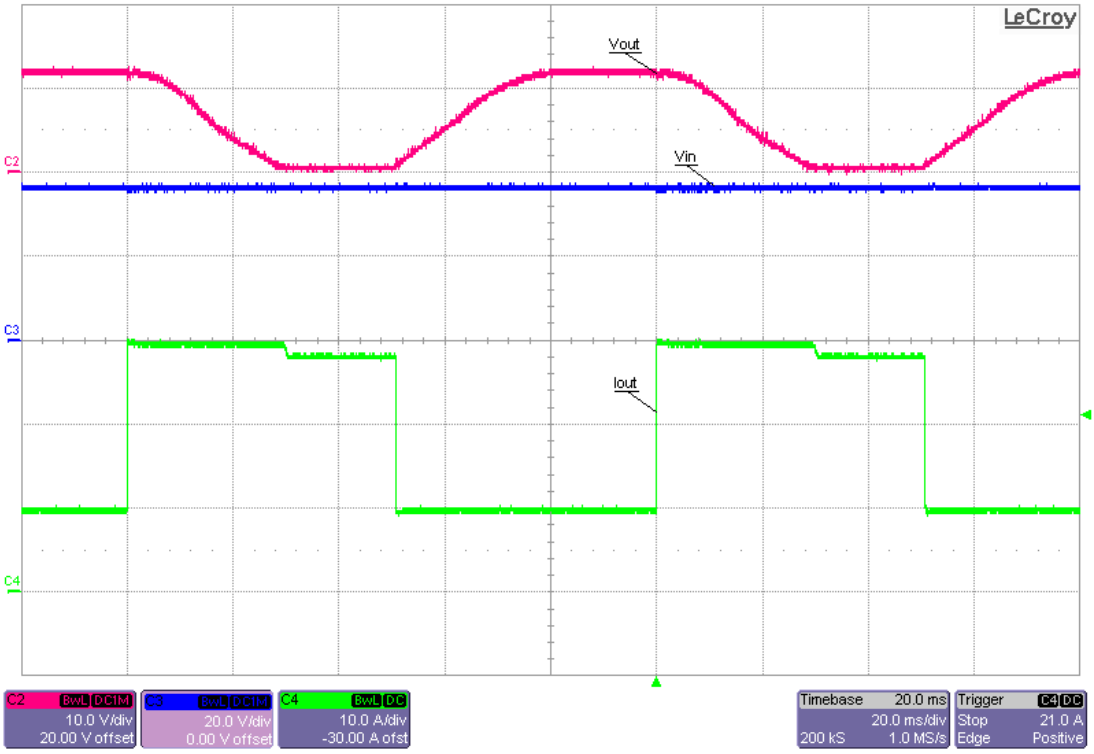
9Vin, 12Vout, 10A to 30A load step, Ch2 Vout, Ch3 Vin, Ch4 Iout



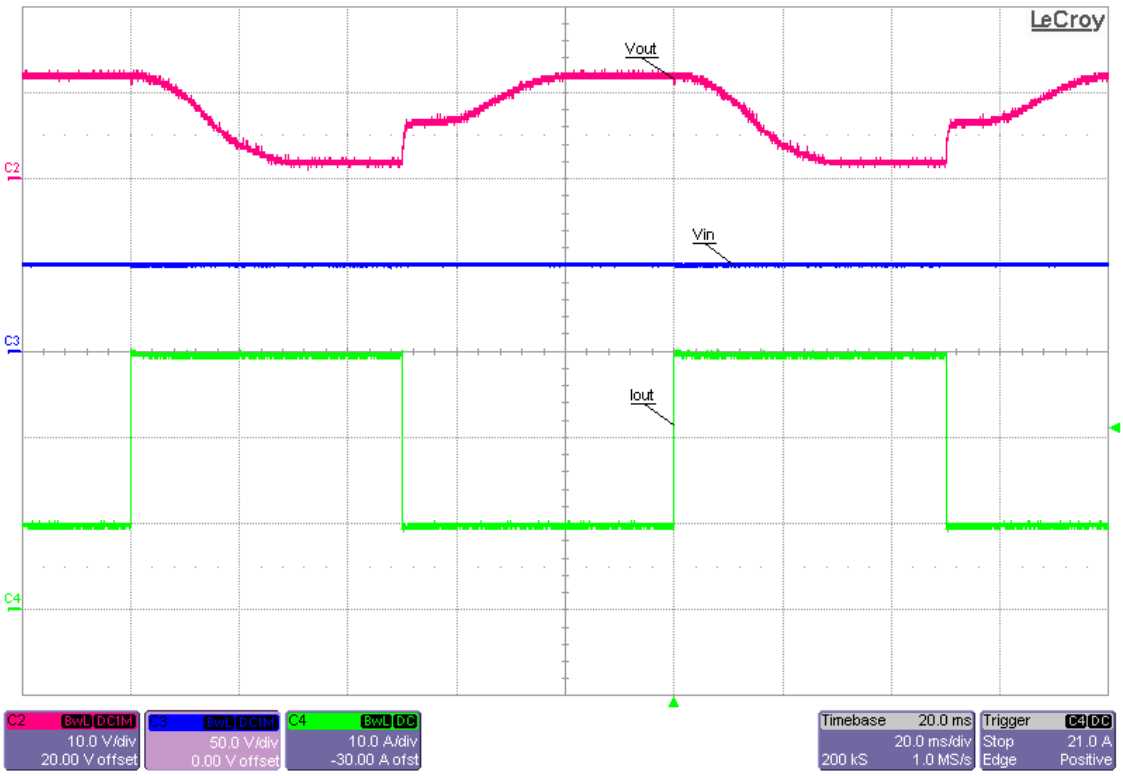
12Vin, 12Vout, 10A to 30A load step, Ch2 Vout, Ch3 Vin, Ch4 Iout



24Vin, 12Vout, 10A to 30A load step, Ch2 Vout, Ch3 Vin, Ch4 Iout

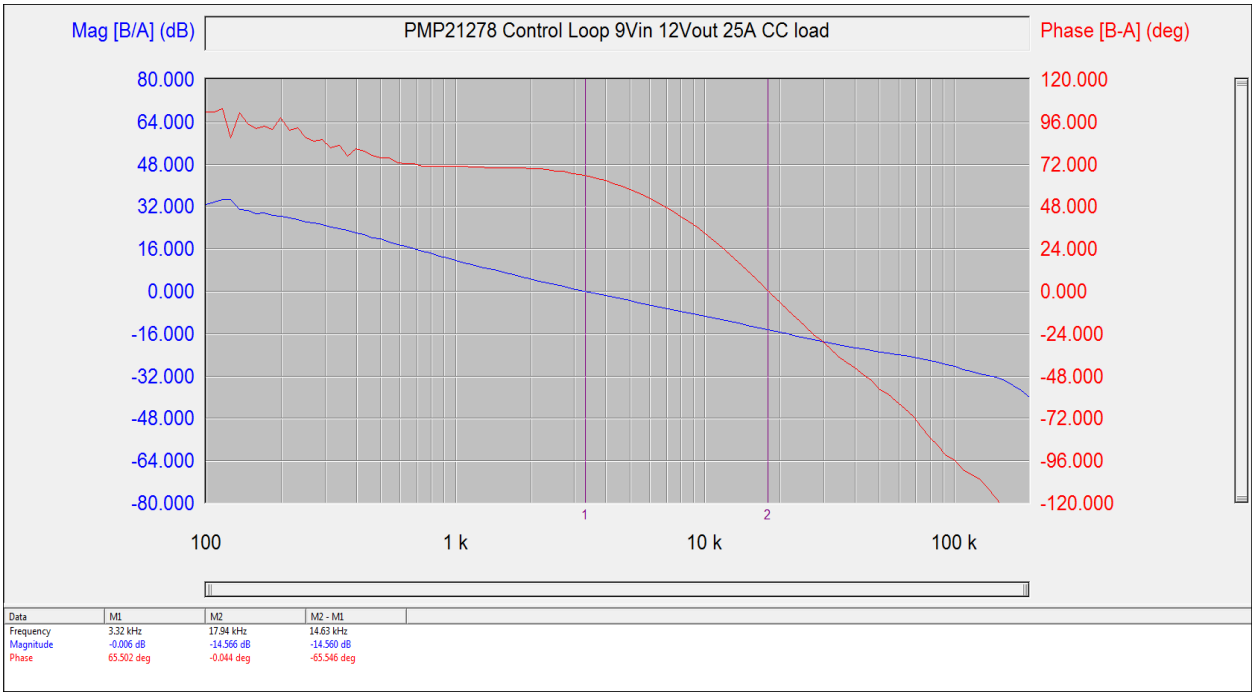


36Vin, 12Vout, 10A to 30A load step, Ch2 Vout, Ch3 Vin, Ch4 Iout

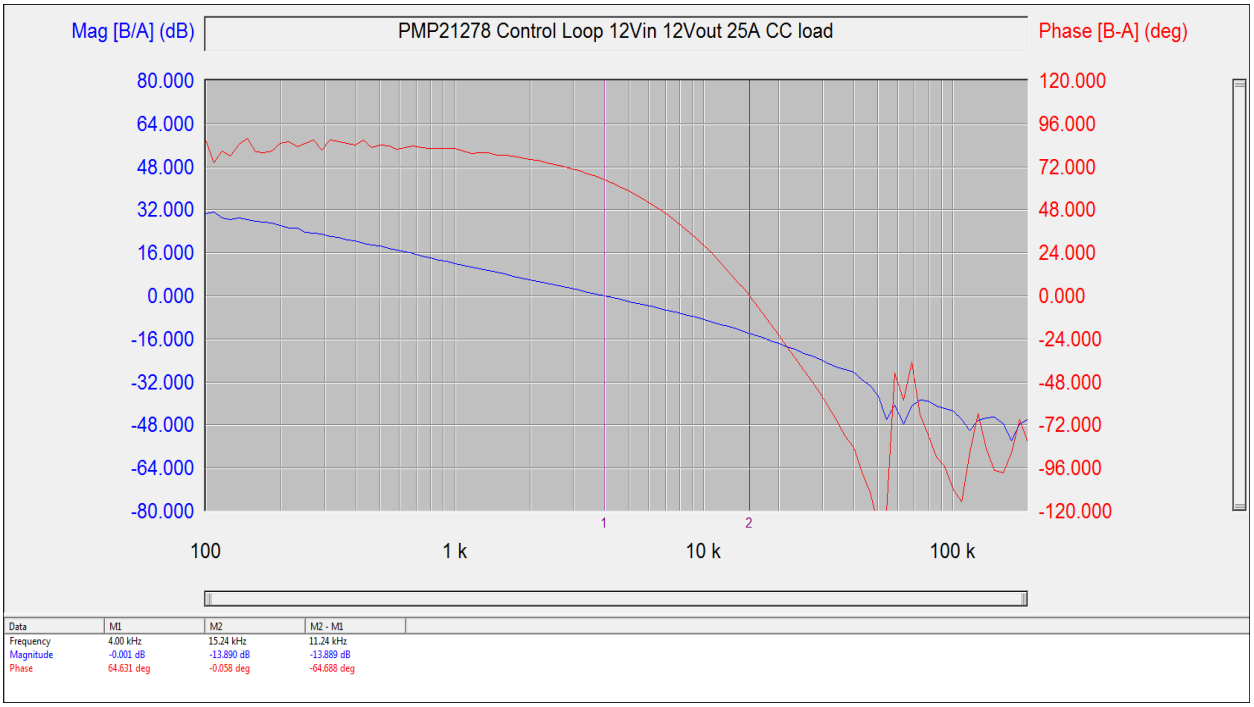


50Vin, 12Vout, 10A to 30A load step, Ch2 Vout, Ch3 Vin, Ch4 Iout

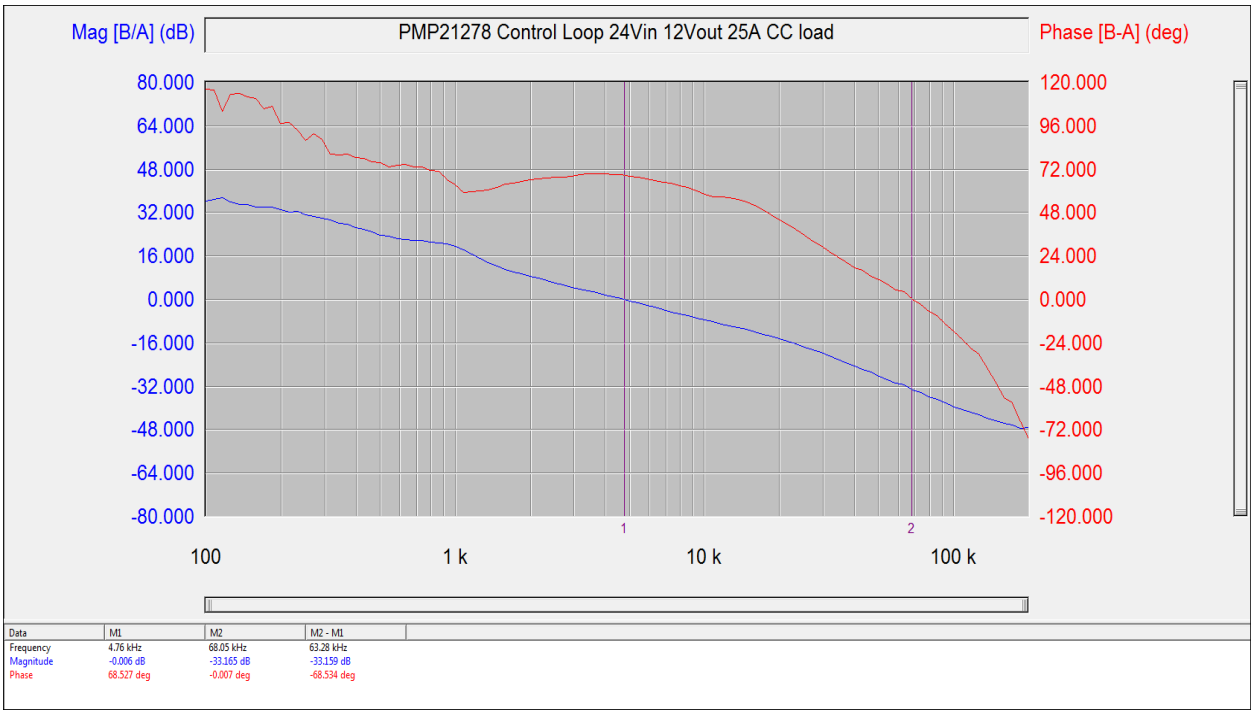
6.7 Bode Plot



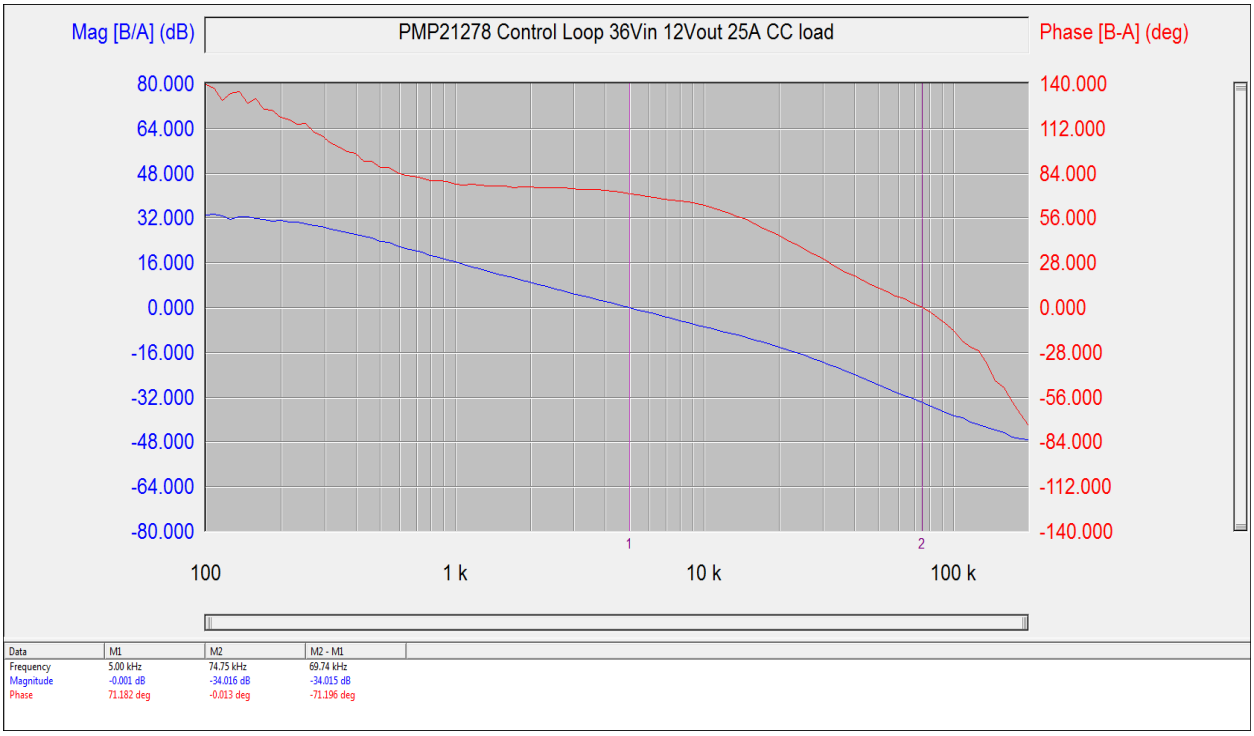
Bode plot taken at 9Vin, 12Vout @ 25A, phase margin is 65.5 degrees, gain margin is 14.57dB.



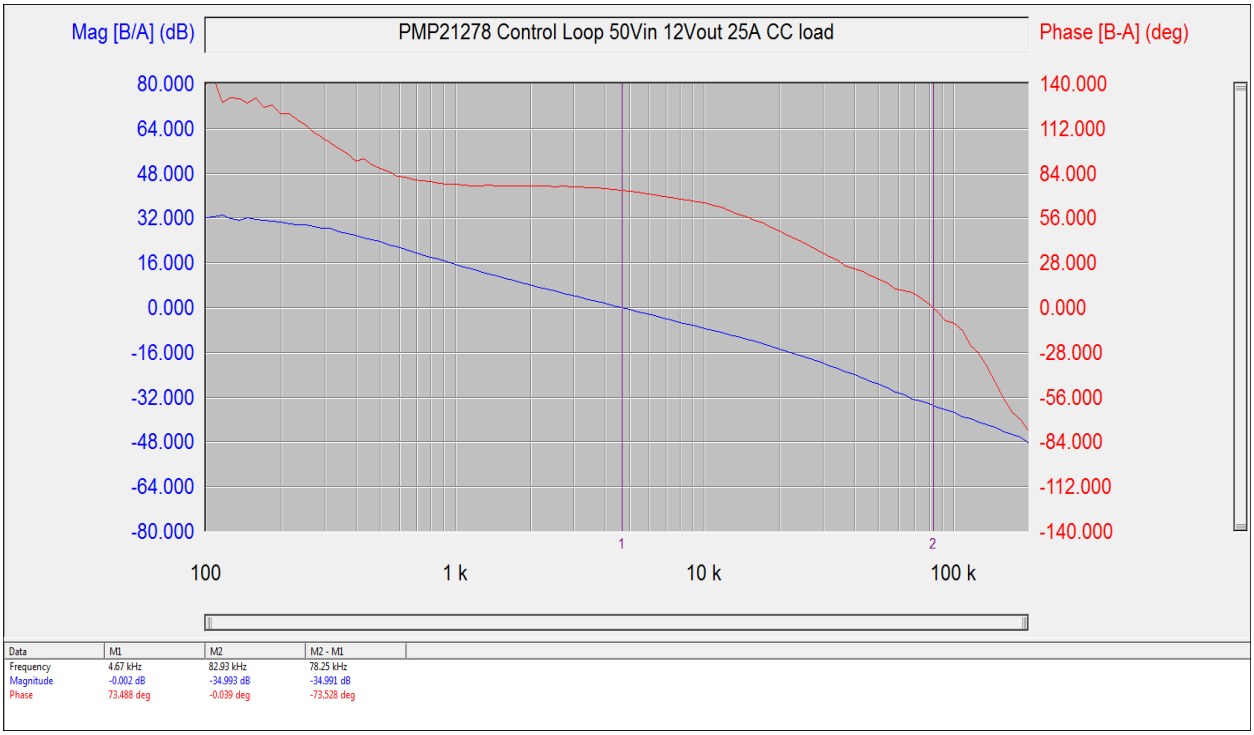
Bode plot taken at 12Vin, 12Vout @ 25A, phase margin is 64.63 degrees, gain margin is 13.89dB.



Bode plot taken at 24Vin, 12Vout @ 25A, phase margin is 68.53 degrees, gain margin is 33.17dB.



Bode plot taken at 36Vin, 12Vout @ 25A, phase margin is 71.18 degrees, gain margin is 34.02dB.



Bode plot taken at 50Vin, 12Vout @ 25A, phase margin is 73.5 degrees, gain margin is 35dB.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (https:www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265